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**NAVAL
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MONTEREY, CALIFORNIA

THESIS

**A LITTORAL COMBAT SHIP MANPOWER ANALYSIS
USING THE FLEET RESPONSE TRAINING PLAN**

by

Mckinnya J. Williams-Robinson

March 2007

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**A LITTORAL COMBAT SHIP MANPOWER ANALYSIS USING THE FLEET
RESPONSE TRAINING PLAN**

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MASTER OF SCIENCE IN OPERATIONS RESEARCH

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ABSTRACT

The Littoral Combat Ship, in its final steps toward employment, is an entirely new breed of U.S. Navy warship. USS FREEDOM (LCS 1), scheduled to be commissioned in May 2007, introduces an advanced technological platform. It includes but is not limited to several new optimal manning and training concepts such as SHIPTRAIN and SMARTSHIP introduced by the U. S. Navy. The Littoral Combat Ship Wholeness Concept of Operations requires a crew to certify in 15 mission areas using its core crew and one additional mission area applicable to both the core crew and mission module personnel.

Using a discrete event simulation tool called the Total Crew Model, this study analyzed the currently proposed Fleet Response Training Plan for Littoral Combat Ship. An examination using a 14-day training cycle snapshot of the 40 proposed crewmembers was found to be sufficient to sustain the ship through a training assessment phase.

The snapshot evaluated crew endurances using 63, 67 and 70-hour work weeks. The modeling showed the 70-hour workweek satisfied the manpower requirement workload, as delineated in OPNAVINST 1000.16J. This work week, however, exceeded core crew endurances by 594 hours and 42% of the crew exceeded acceptable fatigue levels. The model's results indicate that eight additional core crewmembers are required to conduct the training assessment phase without exceeding core crew endurance.

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LIST OF ABBREVIATIONS AND ACRONYMS

3M	MATERIAL, MANAGEMENT AND MAINTENANCE
AAW	ANTI-AIR WARFARE
AMW	AMPHIBIOUS WARFARE
ASW	ANTI-SUBMARINE WARFARE
ATFP	ANTI-TERRORISM FORCE PROTECTION
AW	AIR WARFARE
C2W	COMMAND AND CONTROL WARFARE
C4I	COMMAND, CONTROL, COMMUNICATIONS, COMPUTER AND INTELLIGENCE
CCC	COMMAND, CONTROL, AND COMMUNICATIONS
CCR	CONTINUOUS CERTIFICATION REQUIREMENT
CM	CORRECTIVE MAINTENANCE
CNSF	COMMANDER, NAVAL SURFACE FORCE
CTT	CREW TRAINING TEAM
DCTT	DAMAGE CONTROL TRAINING TEAM
ETT	ENGINEERING TRAINING TEAM
EW	ELECTRONIC WARFARE
FM	FACILITIES MAINTENANCE
FRP	FLEET RESPONSE PLAN
FRTP	FLEET RESPONSE TRAINING PLAN
FSO	FLEET SUPPORT OPERATIONS
GAO	GOVERNMENT ACCOUNTING OFFICE
HCO	HUMAN CAPITAL OBJECTS
HSI	HUMAN SYSTEM INTEGRATION
IDTC	INTERDEPLOYMENT TRAINING CYCLE
INT	INTELLIGENCE
ISIC	IMMEDIATE SUPERIOR IN COMMAND
ITT	INTEGRATED TRAINING TEAM
LCS	LITTORAL COMBAT SHIP
LCSRON	LITTORAL COMBAT SHIP SQUADRON
LOG	LOGISTICS
MA&D	MICRO ANALYSIS AND DESIGN
MCM	MINE COUNTERMEASURES
MOB-D	MOBILITY-DAMAGE CONTROL
MOB-E	MOBILITY-ENGINEERING
MOB-N	MOBILITY-NAVIGATION
MOB-S	MOBILITY-SEAMANSHIP
NCO	NON-COMBAT OPERATIONS
NEC	NAVY ENLISTED CLASSIFICATION
NFC	NUMBERED FLEET COMMANDER
NSW	NAVAL SPECIAL WARFARE
OM	OPERATIONAL MANNING
OUS	OWN UNIT SUPPORT
P	PRIMARY
PFA	PHYSICAL READINESS ASSESSMENT
PM	PREVENTATIVE MAINTENANCE
POE	PROJECTED OPERATIONAL ENVIRONMENT
ROC	REQUIRED OPERATIONAL CAPABILITY
S	SECONDARY
SAR	SEARCH AND RESCUE
SFTM	SURFACE FORCE TRAINING MANUAL

SMART	SHIP MANNING ANALYSIS AND REQUIREMENTS TOOL
SOF	SPECIAL OPERATIONS FORCE
STT	SEAMANSHIP TRAINING TEAM
SUW	ANTI-SURFACE WARFARE
SW	SURFACE WARFARE
T2Q	TRAIN TO QUALIFY
TCM	TOTAL CREW MODEL
TFOM	TRAINING FIGURE OF MERIT
TORIS	TRAINING AND OPERATIONAL INFORMATION SYSTEM
TYCOM	TYPE COMMANDER
ULTRA-C	UNIT LEVEL TRAINING AND READINESS ASSESSMENT-CERTIFICATION
ULTRA-S	UNIT LEVEL TRAINING AND READINESS ASSESSMENT-SUSTAINMENT
VBSS	VISIT, BOARD, SEIZURE, SEARCH
WQ&SB	WATCH, QUARTER AND STATION BILL

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EXECUTIVE SUMMARY

The U.S. Navy's surface combatant force uses strategic guidance from the Joint Operations Concepts and the Naval Operating Concepts which are integral in achieving the views of Sea Power 21. Sea Power 21's vision continues the evolution of U.S. naval power from the blue-water, war at sea focus to a strategy in which naval forces are fully integrated into global joint operations against regional and transnational dangers.

Sea Warrior, a component of Sea Power 21, is designed to maximize the Navy's Human Capital. Sea Warrior makes manpower personnel managers and sailors aware of skill conversion opportunities, identifies new career paths, training opportunities and introduces them to a wider array of job possibilities by monitoring skills and education.

Optimal Manning is a term used by analysts to describe the coupling of manpower analysis with modern technology to increase capabilities while reducing Naval workload in the operating forces. The design and creation of the Littoral Combat Ship is one effort to assist in this objective. This platform's innovative modular architecture is one of the first to use the hybrid sailor and Human Capital Objects as a manpower requirement tool to reduce manning onboard a frigate-sized ship.

The Littoral Combat Ship is the driving factor to the development of the Navy's new approach to manpower and early training development. An earlier study by LCDR Thaveephone Douangaphaivong outlined and compared several concepts for manning this platform. Utilizing a paradigm

shift in concepts involving Smart Ship and Fleet Optimal Manning Experiment technologies, the study found that a minimal manning of 90-100 still exceeded the original threshold of 75.

Manpower requirements are based on mission, functions, and tasks and/or required operational capability and the projected operational environment. A ship's workload is determined using industrial engineering techniques to yield those manpower requirements. The Littoral Combat Ship's total manpower requirements have been set at 75 and plans are in motion to train the first Littoral Combat sailors prior to stepping onboard. Once the Littoral Combat Ship is commissioned and the core crew of 40 is fully prepared to take the deck, it will enter its first training phase commonly known as the Unit Level Training and Readiness Assessment. This research centered around a 40-member crew conducting its first training certification using completed tasks, fatigue levels, and workload as measures of performance to validate its manpower requirements.

I. INTRODUCTION

The Littoral Combat Ship (LCS) is the first Navy shipbuilding program to develop and utilize the seaframe (core system) concept. The "core" is a system resident to LCS in all configurations with the purpose of carrying out core ship functions such as self-defense, command, control, communications, computer, intelligence (C4I), and other capabilities common to all prescribed mission areas. Theoretically, the LCS seaframe, without any installed mission modules, possesses warfare capabilities such as Surface and Air Warfare and is therefore a "warship." The core's sensors and weapons are capable of safe navigation, can receive and contribute to the Common Tactical Picture (CTP) and will perform operational tasking consistent within its designed capabilities.

The seaframe's mission capabilities are enabled by the ship's core systems and characteristics. These capabilities include replenishment and refueling at sea for both an MH-60R/S helicopter and the seaframe itself; support for Special Operations Forces (SOF); launch, recovery and maintenance of embarked manned and unmanned craft, limited combat search and rescue; humanitarian and disaster relief, and Anti-Terrorism Force Protection (ATFP). Though its intrinsic systems have the functional capabilities found in legacy platforms (legacy operating systems that have been succeeded by an updated version of earlier technology), the bulk of LCS's warfighting competence is provided by focused, interchangeable modular mission packages. These interchangeable and tailored combat systems packages will

outfit the seaframe using a modular architecture that will support specific missions and tasks. Mission capabilities include Mine Countermeasures (MCM), Anti-Surface Warfare (SUW) and Anti-Submarine Warfare (ASW). Ultimately, the overall seaframe concept allows LCS to have a smaller core crew to operate core capabilities. When outfitted with any one of the three mission modules, each module brings with it the personnel required to operate and maintain the mission package equipment. A shore based infrastructure, manned with an augmented crew and additional personnel, will provide own unit support (OUS) functions such as messing, administration, medical support and maintenance.

There are currently two designs for LCS Flight 0 ships. While both designs are minimally manned with the same number of crewmembers, each has slightly different training prerequisites for the 75 respective manpower requirements. Additionally, the seaframe concept is designed to rotate blue and gold crews. The first of these classes, USS FREEDOM (LCS 1), built by Lockheed Martin (Figure 1) in Marinette, Wisconsin was christened and launched on September 24, 2006 at the Marinette Marine Shipyard. The second, USS INDEPENDENCE (LCS 2), built by General Dynamics, had its keel laid on Jan 19, 2006 in Austal USA Shipyard, Mobile, Alabama.



Figure 1. Lockheed Martin's LCS Seaframe

This modular approach to multi-mission ship design presents an innovative paradigm shift with regard to manpower and training requirements. LCS is being built to accommodate 75 crewmembers, 40 of which are assigned to the seaframe, 15 to the mission modules and 20 to the augmented aircrew. The training requirements for each sailor assigned to the LCS, according to the Preliminary Design Interim Requirements Document,¹ will use a human-centered design approach to automate decision processes that optimize manpower workload. The seaframe exploits SMARTSHIP technologies to decrease personnel workload without compromising the design capability to fulfill mission requirements. This is done to the maximum extent practicable in order to provide on-demand individual and team training mission rehearsal capability, both inport and underway.

The LCS training infrastructure will incorporate a responsive and flexible training architecture in order to deliver a full range of training products and services wherever and whenever required. The onboard training systems will span the training continuum from warfare capabilities, maintenance, and logistics to professional, military, leadership and personal enrichment training. This approach cultivates the total sailor and supports the tenets of Sea Warrior. Another feature of the training system is its availability to exercise all levels of progressive, basic, intermediate, and advanced training, which includes team, unit, group, joint, and coalition training that culminates in unrestricted operations

¹ Preliminary Design Interim Requirements Document (PD-IRD), Serial No: N763F-S03-026 for LCS Flight 0 Pre-ACAT, February 10, 2003.

certification. A mixture of modeling and simulation systems, embedded on-board trainers, web-enabled or PC-based distance learning systems, and netted classroom environments will be installed to facilitate this paradigm shift in manpower and training philosophies.

II. SCOPE OF STUDY

This research models the LCS training cycle by employing task network models to solve manning optimization issues developed at Micro Analysis and Design (MA&D), now Alion Science. Current guidelines for calculating workload distribution include hours expended on Operational Manning (OM) or Watchstanding, Own Unit Support Evolutions, Preventive Maintenance (PM), Corrective Maintenance (CM) and Facilities Maintenance (FM) as well as hours spent on Training and Service Diversion. To determine manpower requirements, the maximum expected crew endurance for Condition III is 21 consecutive days underway, with the opportunity for eight hours of rest provided per crewmember per day, followed by 4 days in port.²

The measures of performance for the model in this study are maximum crewmember endurance (fatigue) levels, all tasks that support unit level certifications and productive hours expended in a workweek to include only own unit support and training evolutions. It is assumed for this research, that all maintenance evolutions are deferred until the completion of the training assessment.

In common practice on legacy platforms, after a training assessment is completed the applicable Commander, Destroyer Squadron would provide a message summary to the Numbered Fleet Commander (NFC) via Commander, Naval Surface Force (CNSF), detailing the completed training objectives specifically noting any areas requiring further training and a recommendation regarding readiness for independent

² OPNAV INSTRUCTION 3501.352, Rough Draft, 09 August 2006.

deployment. When all certifications are completed, the Fleet Commander certifies the ship as ready for independent deployment.

In simulating an LCS training assessment, the Total Crew Model (TCM) will delineate a detailed output of each crewmember's fatigue level, total workload hours expended and a pass or fail status of each task in support of certifications required for independent deployment.

III. BACKGROUND

A. TRAINING

The LCS concept signifies a considerable departure from current organizational training configurations found in today's combatant fleet. It also begins the revolution in training Navy warships. To ensure LCS acts as a force multiplier, it will conduct readiness training through newly designed embedded continuous training simulators, which significantly differs from current training standards and processes. In order to establish a baseline of training readiness for LCS, a tailored ship's training plan using the SHIPTRAIN concept and an adaptation of COMNAVSURFORINST 3502.1C (Surface Force Training Manual) (SFTM) has been developed.

SHIPTRAIN, implemented in February 2006, is an innovative approach to the continuous training process expected to reduce the 16-week cycle to approximately four the time to train, assess and certify a ship as ready for independent deployment.

SHIPTRAIN is a revolutionary process improvement that provides the measurement tool to sustain unit proficiency at the most effective and efficient level of operational readiness.

The LCS's tailored ship training plan is designed to train crews nearing certification expiration in a 14-day period with a precursory 7-day crew readiness period. Within this readiness period, all mandatory administrative, medical and dental records are updated, re-qualifications and general military training completed, and the mandatory semi-annual Physical Fitness Assessment (PFA) accomplished.

Using current SFTM certification tabs as a model, an assessment criterion for LCS crew certification is tailored by specific core mission areas, which are designated in OPNAVINST 3501.352, a rough draft of the LCS Required Operational Capability/Projected Operational Environment (ROC/POE). The Primary (P) and Secondary (S) warfare mission areas are assigned and shown in Table 1.

LCS 1 (FREEDOM) Class											
AAW	AMW	SUW	CCC	C2W	FSO	INT	LOG	MIW	MOB	NCO	NSW
S	S	* P	P	S	S	S	S	* P	P	S	S

Table 1. Notional LCS ROC/POE

Primary mission areas included in the LCS ROC/POE are Surface Warfare (SUW), Command, Control and Communication (CCC), Mine Warfare (MIW) and Mobility (MOB) while secondary mission areas are Anti-Air Warfare (AAW), Amphibious Warfare (AMW), Communication and Control Warfare (C2W), Fleet Support Operations (FSO), Intelligence (INT), Logistics (LOG), Non-Combat Operations (NCO) and Naval Special Warfare (NSW). The asterisk (*) represents the focused primary mission areas when the seaframe is outfitted with the respective focused mission package. AMW is not a design capability and will be updated in the next ROC/POE.

The SFTM is the primary source of policy, requirements and directions for all aspects of Unit Level training and certification in support of the Fleet Response Plan (FRP), a plan that provides adaptable, flexible and sustainable

naval forces to support combatant commanders while maintaining a global forward presence. The current Fleet Response Training Plan (FRTTP) meets the requirements of the FRP and replaces the former Inter-deployment Training Cycle (IDTC). The SFTM will provide the foundation to maintain continuous readiness and certifications prior to and throughout the employment cycle using the Training Figure of Merit (TFOM) and Training and Operational Information System (TORIS). TFOM and TORIS integration is shown in Figure 2.

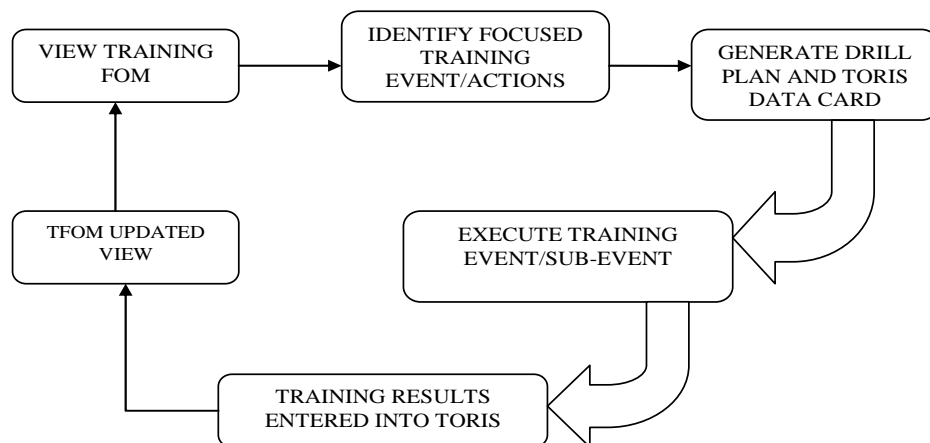


Figure 2. TFOM/TORIS Shipboard Training Integration (After Surface Force Training Manual)

TFOM is a readiness indicator in stoplight format, used by the Immediate Superior in Command (ISIC) and ship to determine where focused training efforts are needed to maintain readiness and operational excellence. Since readiness and continuous training is center mass for everything naval ships do, the goal of Unit Level training

is phased to ensure the ship's training teams are able to effectively train and assess themselves. Another major shift for LCS operations compared to legacy ships is the requirement to have training teams in each of the critical mission areas. Legacy ships require a Seamanship Training Team (STT), an Engineering Training Team (ETT), a Damage Control Training Team (DCTT) and an Integrated Training Team (ITT). However, the LCS core crew of 40 requires each crewmember to contribute to all required watchstanding responsibilities, leaving the ISIC and an augmented LCS Squadron (LCSRON) the task of enhancing the ship's crew into a newly created Crew Training Team (CTT), comparable to the ITT.

The current SFTM requires the LCS to complete 15 certifications, with each consisting of at least eleven or more required subtasks, using the 40 core crewmembers. This requirement varies significantly from the requirements of a single mission platform such as the Mine Countermeasures (MCM) ship in that LCS certification tasks will take up 37.5% of productive work during normal operations. The MCM, whose mission to clear mines from waterways, detect, classify and neutralize all known and projected types of contact mines, is required to complete 12 certifications using 72 crewmembers according to SFTM taking up 17% or less than half of an LCS's productive work required during normal operations.

The establishment of an LCS training and readiness standard caused Afloat Training Group (ATG) to adapt and tailor detailed criteria found in SFTM certifications tabs for the following 15 specific core certification areas:

1. Aviation (AIR)
2. Anti-Terrorism/Force Protection (AT/FP)
3. Air Warfare (AW)
4. Command, Control and Communications (CCC)
5. Electronic Warfare (EW)
6. Medical (FSO-M)
7. Intelligence (INT)
8. Damage Control (MOB-D)
9. Engineering (MOB-E)
10. Navigation (MOB-N)
11. Seamanship (MOB-S)
12. Surface Warfare (SW)
13. Visit, Board, Search and Seizure (VBSS)
14. Maintenance and Material Management (3M)
15. Search and Rescue (SAR)

ATG will assist the ISIC in preparing USS Freedom (LCS 1) for deployment and transitioning as part of the readiness continuum. This training methodology supports the robust operational schedule planned for LCS seaframes and crews.

This study will mainly focus on core crew certifications found in the ROC/POE excluding MIW. MIW should be included in future studies when augmented with MIW Mission Module personnel. Additionally, Material, Maintenance and Management (3M) is excluded due to no more than four administrative tasks required for certification.

Warfare certifications are associated with the crews, not the seaframe. Therefore, LCS core and mission module crews must satisfy Continuous Certification Requirements (CCRs) before the Type Commander (TYCOM) grants independent deployment certification. While crew proficiency will be maintained using a mixture of simulators and seaframe (core), some evolutions can only be performed in the simulator, while others will be conducted exclusively onboard the seaframe. If a seaframe is not available, then the simulator equivalent may be used to maintain proficiency.

Preliminary certification requirements identified in SFTM will be subject to ongoing updates and refinements. As CNSF's training agent, ATG will assist the ISIC in preparing USS Freedom (LCS 1) for its initial crew certification and training cycle.

B. MANNING

The LCS's unique manpower concept is the Navy's first major paradigm shift in manning warships. According to the U.S. Government Accounting Office (GAO), manpower is the single most influential component in the life cycle cost of a ship. This cost is largely determined by the decisions made during a system's concept design. The most encouraging aspect of the optimally manned crew aboard the LCS is the capability to minimize this cost. Since primary systems tend to require frequent updating, so must personnel training. The LCS's overall manpower cost should significantly decrease cost through embedded training systems. However, this reallocation of manpower presents a

new question: Can an optimally manned warship of 40 crewmembers be adequate to complete all tasks associated with crew certifications within acceptable crewmember fatigue levels and workload hours found in Navy standard workweeks?

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IV. PROBLEM AND OBJECTIVE

A. PROBLEM

LCS-1's current deployment schedule has it leaving its homeport within six months of commissioning. While underway, LCS is required to maintain training readiness throughout each operational phase of its deployment. Crew certification is mandatory for all new construction ships in which an emphasis is placed on the review of the ship's overall training program, the ability to provide a minimum number of qualified crewmembers to support all underway requirements, and whether all training objectives are being satisfied. After the crew certification period, core crews will experience an evaluation within the initial phase of training called the Fleet Response Training Plan (FRTTP). This assessment is called the Unit Level Training and Readiness Assessment (ULTRA). It is notable that each seaframe will be assigned mission(s) according to the area(s) in which the crew has been certified. Thus, depending on current certification status and is what mission area, the crew will either conduct a three-day or two-week long ULTRA-S (Sustainment) or ULTRA-C (Certification). This assessment is administered by the ISIC and ATG, using the basic guidance from SFTM, and serve as validation of TFOM proficiency levels. The current challenge is whether a core crew of 40 can effectively complete an extensive 14-day training assessment within acceptable fatigue levels. Figure 3 depicts a 14-day ULTRA-C assessment.

Unit Level Training			
Crew Readiness Period	ATG/ISIC ULTRA-C Certification	LTT/Team Trainers/Classroom Training	Mission Package
GMT Small-Arms Requal PFA Dental Medical Admin	15 Core AIR ATFP AW CCC EW FSO-M INT MOB-D MOB-E MOB-N MOB-S SW VBSS 3M SAR	Aviation ATFP VBSS SAR DC Engineering Navigation Seamanship Combat System 3M Assist	Install Integrate Test GWOT MIW ASW SW
7 Days	14 Days	28 days	14 Days

Figure 3. Snapshot of a 63-day ULTRA-C LCS Training and Deployment Continuum-Certification Nearing Expiration. (After the SFTM) The Crew Readiness Period and Ultra-C Certification comprise the 21 days used in this research.

B. OBJECTIVE

Micro Analysis & Design (MA&D), a proprietary company with offices in Boulder, CO and Orlando, FL, created models that would provide substantive and well-supported outputs regarding human-system performance predictions. The Total Crew Model (TCM) is a dynamic simulation architecture built using task-network modeling.

This model succeeds in primarily organizing a structure of task sequences while exploring the larger aspects of human system behavior decomposed into smaller task elements. TCM was initially developed to simulate shipboard manning requirements for naval surface vessels.

In a previous study, it was found that the development of crew schedules and watch, quarter and station bill (WQ&SB) assignments in a static fashion often left gaps or inconsistencies not easily uncovered. It was found that these inconsistencies could be revealed in a dynamic environment. TCM was designed to evaluate the manpower requirements from a dynamic perspective to determine the adequacy of a proposed crew complement.

Simulation results are used to determine if the assigned crew complement can successfully accomplish all underway operations within an acceptable time and crew fatigue levels. A simulation will be evaluated using the core crew standing watches, performing normal work, and minimal maintenance during a unit level training assessment, while meeting fatigue levels within a prescribed standard Navy workweek.

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V. THE TOTAL CREW MODEL

A. HISTORY

Discrete event simulation is a way of building models to observe the time based (or dynamic) behavior of a system. These models run by building a network of individual tasks that must be performed together to create an event. Each of the tasks, though simple by themselves, can simulate a complicated scenario when combined. These simple tasks are connected using logic statements and probabilities that can further increase the complexity of the model. Event simulations are made of many components including, but not limited to, entities, logic statements, random number generators, and data collection systems.

Micro Saint 4.1 is an example of a discrete event simulation tool. Others include IMPRINT and SEAPRINT, which are used by individuals and companies to assist in predicting manpower requirements. Micro Saint 4.1 was designed to model the impact of human interaction in operational systems of varying complexity, and meeting realistic expectations. This software has been used by Micro Analysis and Design (MA&D) on DD21 and other projects. It is the base program of the more refined manpower estimation tools that were explored for use in this and other studies.

MA&D further developed an estimation tool known as the Total Crew Model (TCM). This specific model can effectively be used to validate a Watch, Quarter and Station Bill, as well as current or anticipated manning philosophies. This modeling tool has many output files that can be used to

analyze manpower requirements and personnel practices onboard LCS. One output will determine whether a ship's crew can perform all of the ship's assigned missions within an acceptable level of crew fatigue.

TCM considers the combined effects of crew's, daily schedules, WQ&SB assignments, and specific manning requirements for special evolutions and other crew activities. These input data are integrated dynamically over the course of a designed mission scenario and provide the data necessary to assess the adequacy of the proposed manning structure during each scenario.

Though primarily used in-house by MA&D on consulting projects, the establishment of the Naval Postgraduate School's (NPS) Human System Integration (HSI) program has created faculty and student relationships with consultants at Alion Science. Consequently, Alion consultants have assisted students interested in utilizing this model in data analysis research. Students choosing to use TCM and Micro Saint 4.1 as part of their research must abide by a Non-Disclosure Agreement addressing the individual use of Micro Saint and the Total Crew Model that must be signed to cover proprietary concerns.

B. OTHER MODELING TOOLS

The U. S. Navy contracted MA&D to develop another valuable shipboard manning prediction tool. The Ship Manning Analysis and Requirements Tool (SMART) series of programs were developed to allow designers to vary the parameters of equipment, maintenance, and levels of automation to optimize the crew size of a ship based on

four goals. The first goal minimizes the overall cost, while the second and third goals minimize crew size and the number of different ratings on the ship. The fourth goal minimizes the workload for each crewmember. Combined together these four goals provide a basis for the latest program in the series, SMART build 3, which has effectively integrated all parameters to conduct a manning analysis.

Operationally, developers have created libraries of navy equipment and maintenance procedures that are part of the software that supports the algorithm. The researcher uses this data to develop a scenario that tests the crew's ability to operate in specific required mission areas. The scenario is broken up into smaller tasks using Micro Saint. Each scenario task has a list of the skills required to perform the task. SMART dynamically allocates each task to a member of the crew who has the required skills to perform the mission and is available at the beginning of the task. SMART conducts the function allocation based on a categorization created by Dr. Edwin Fleishman and on the level of automation that is specified by the user. A built-in function allocation algorithm helps to build a crew consisting of enough personnel to meet manpower and mission requirements. The user does not need to spend time assigning specific tasks to the simulated crew for each iteration of the scenario. The program runs a discrete event simulation to test the manpower requirements, maintenance, and automation configurations to evaluate alternative manning and automation concepts prior to implementing technology.

The use of SMART for future studies would provide a more in-depth analysis not only of manpower requirements but also required maintenance both aboard and ashore as well as effects of automated configurations onboard LCS.

VI. LCS ATTRIBUTES AND ASSUMPTIONS

A. CREW

LCS is the first ship on which manning and training requirements were determined based on the development of Human Capital Objects, leveraging the significant work accomplished in Job/Task Analysis and skills-based assessment.

Though comparable in size to today's frigate, the LCS seaframe is so technologically advanced that it is envisioned to require less than half the crew of a frigate to carry out its missions. While a frigate goes to sea with a crew of approximately 200, it is expected that the LCS seaframe be manned by a core crew of 40: eight officers and 32 enlisted personnel. Additional personnel are stationed ashore to provide the significant support that exists onboard today's legacy platforms. In addition, 35 non-core crewmembers will be assigned to specific mission modules.

USS Freedom (LCS 1) manning and training requirements were determined using Human Capital Objects (HCO), a detailed description of objects that identify all work, including watches and collateral duties required by the crewmembers assigned. LCS is the first ship that Human Capital Objects were developed to determine the manpower requirements. Human Capital Objects included operating the systems, watch rotations within occupational workloads, and execution of collateral duties. With a total projected crew of 75, the required optimally manned FREEDOM demands that its crewmembers have skills in more than just their rating. Using a blend of skills from several ratings, this approach optimizes manpower workload and creates a new, or hybrid, Sailor.

Another training and manpower concept successfully used by the Navy's aviation community and civilian maritime industry for years, Train to Qualify (T2Q), envisions everyone reporting aboard LCS ready to fulfill all of their rating and watch duties, both individually and as an integral part of the crew. The most important change with this approach as opposed to legacy approaches is that each Sailor is evaluated by a strict reference to uniform measures, metrics and standards before they report to LCS.

Hybrid sailors will be required to demonstrate proficiencies in their job tasks before they report for duty. This is intended to maintain certification with minimal on-the-job training.

Every sailor stationed aboard LCS will be assigned a specific numbered billet defined by tasks that range from their individual rating or Navy Enlisted Classification (NEC) codes. The entire detailing process has undergone continual updating to incorporate time for all the training a sailor must get before stepping aboard. LCS billets will become available 18-24 months before a scheduled loss instead of the current policy of 9-12 months.

Once a Sailor is chosen to fill an LCS billet, their individual training track will be developed and they will be trained for their particular skills. This training will be accomplished by a combination of online, classroom, and simulator training. LCS sailors will be required to broaden their knowledgebase and prepare to multitask using complementary skills. Figure 4 shows the initial billets assigned to USS Freedom (LCS 1). The corresponding billets

used throughout this study do not match the numbers below due to constant updates submitted to LCS Squadron (LCSRON), USS Freedom's ISIC.

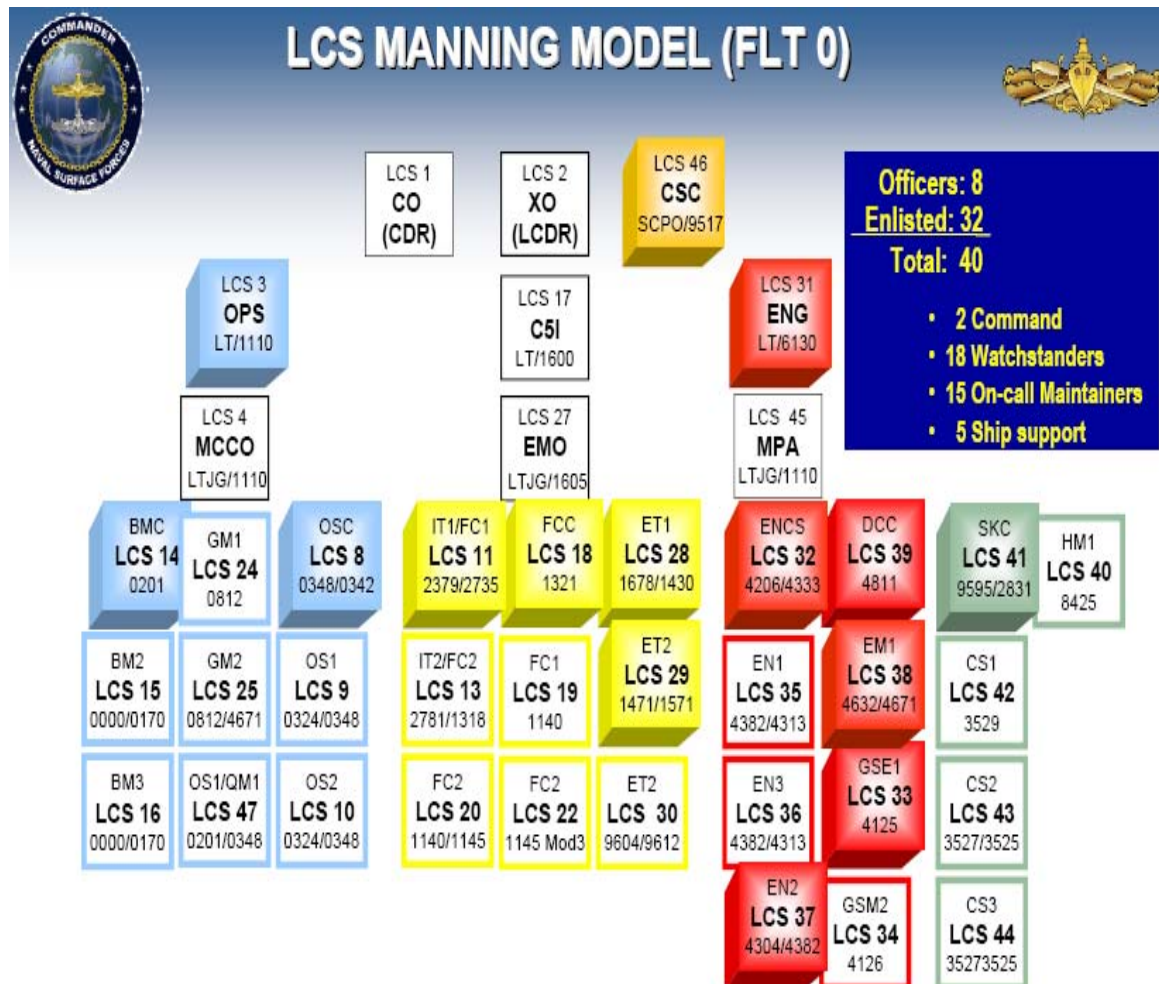


Figure 4. USS Freedom (LCS 1) Initial Manning Model to include Billets by Human Capital Object (HCO) numbers

B. NOTIONAL LCS WQ&SB

A Watch Quarter and Station Bill (WQ&SB) for U.S. Navy Ships designate personnel by name, rank, and billet for each casualty situation, i.e., fire, flooding, man overboard. ATG San Diego has developed a notional WQ&SB

featuring the required Freedom manpower billets and who will be qualified to fill each station. As, the notional WQ&SB, found in Figure 5 on the following page, demonstrates that the Command Master Chief (CMDCM), Billet 40, will stand Junior Officer of the Deck (JOD) as a primary watchstation. In another example, the Chief Storekeeper (SKC), Billet 35, will have a primary watchstation as a Crew-Served Weapons Gunner (CSW) and Helo Control Officer as a secondary watchstation. One major change in core crew billets from Figure 5 is the replacement of Boatswain Mate Second Class (BM2) and Boatswain Mate Third Class (BM3) with two First Class Mineman. Appendix A features all crewmembers assigned to LCS 1.

CONDIII										Additional CONDI																			
			Combat										Firefighting					Flight Quarters					CondIII Nav						
Billet	Rank	Name	OOD	JCD	RCO	EPT	TAO	RNS	DBO	TSC	COM	ACT	GRC	5M	CSW	DC	RLO	HCO	LSE	CST	CCO	NAV	LHO	CAP	LHR				
Sect 1	40	OMDM		P											P	P	P					(X)							
	36	SKC		A											P	P		A		P					P				
	39	LT	P		A											P													
	30	ENC				P										P							P						
	3	LT	A				P									P													
	7	OSC						P				P				P							P						
	15	ETCS							P						P	P									P				
	9	IT1								P			P	P		P			P	P					P				
	18	FOC									P					P	P		P		P		P		P				
	20	GM												P	P	P	P												
13	MNI												P	P	P	P			A	P		P		P					
27	GSEI			P												P				P	P		P		P				
36	CSI														P	P									P				
Sect 2	4	LTJG	P													P		P		P		P							
	11	BMC		P											P	P	A		P	P									
	26	ENC			P											P								P					
	28	GBM2				P										P				P					P				
	14	LCDR	A				P									P	P												
	6	OSC						P				P				P									P				
	16	FCI							P							P	P												
	22	ET1								P						P	P				P				P				
	23	ET2									P					P	P				P		P		P				
	19	GMC											P	P	P	P				P									
	31	ENI														P	P						P		P				
	37	CS2														P	P								P				
	Sect 3	21	LT	P													P	A	P		P								
5		QMC		P											P	P		A		P		P							
33		DDC			P											P				P					P				
32		EMI			A	P										P				P				P	P				
25		LCDR	A				P									P	P						P						
8		CSI						P				P				P								A	P				
17		FC2							P							P				P					P				
10		IT1								P						P	P			P	P			A					
24		ET2									P					P	P				P		P		P				
12		MNI														P	P		A	P			P		P				
29		ENC														P	P						P						
38		CS2														P	P				P	P		P	P				

Figure 5. Snapshot of the Notional LCS 1 WQ&SB assigning watchstations to all 40 crewmembers

C. NOTIONAL BLUE/GOLD INPORT WATCHBILL

While inport, both blue and gold crews will be expected to support the seaframe. Through training, medical, administrative or watchstanding support, all qualified watchstanders will support their respective duty section even on their off duty days. A scheduling assumption made for this study was to create three section inport and underway duty sections for both blue and gold crews. This entering assumption allows the Commanding Officer, Executive Officer and Senior Watch Officer the

flexibility in assigning duty while inport using three options. Table 2 shows three potential options for inport watch rotations.

Three Section Watch Rotation-Inport		
Option 1	Option 2	Option 3
Blue-1	Blue-1	Blue/Gold-1
Blue-2	Gold-1	Gold/Blue-2
Blue-3	Blue-2	Blue/Gold-3
Gold-1	Gold-2	Gold/Blue-1
Gold-2	Blue-3	Blue/Gold-2
Gold-3	Gold-3	Gold/Blue-3

Table 2. Optional Inport Duty Section Rotations

This flexibility will allow duty sections to stand duty every six days instead of every three. An additional assumption made is that longer watches would accommodate smaller duty sections. Thus, watchstanders stand a six-hour rotation versus the current practice of four-hours. For the purposes of this study, Option One referenced in Table 2, without the gold crew, is modeled for analysis. Ultimately the scenario used in this research depicts the blue crew standing duty every three days. Figure 6 shows an example of watchstation assignments for Blue Section One, days one and seven.

DAY ONE				
Duty Section 1				
CDO:	CHENG (b)			
Section Ldr	ETCS (b)			
RLO	AOPS (b)			
	0900-1500	1500-2100	2100-0300	0300-0900
OODi	SKC (b)	ETCS (b)	OSC-1 (b)	SKC (b)
POW	IT1-1 (b)	FCC (b)	FCC (b)	MN1-1 (b)
RCOi	GSE1 (b)	ENC-1(b)	AOPS (b)	GSE1 (b)
EPTi	GSE1 (b)	ENC-1(b)	AOPS (b)	GSE1 (b)
CSW		Fire Party/RRT		
SKC (b)	Investigator	AOPS (b)		
ETCS (b)	Investigator	ENC-1 (b)		
FCC (b)	Nozzleman	IT1-1 (b)		
GM1 (b)	Hoseman	GSE1 (b)		
MN1-1 (b)	Hoseman	IT1-1 (b)		
CS1 (b)				
DAY SEVEN				
Duty Section 1				
CDO:	CHENG (b)			
Section Ldr	ETCS (b)			
RLO	AOPS (b)			
	0900-1500	1500-2100	2100-0300	0300-0900
OODi	SKC (b)	ETCS (b)	OSC-1 (b)	SKC (b)
POW	IT1-1 (b)	FCC (b)	FCC (b)	MN1-1 (b)
RCOi	GSE1 (b)	ENC-1(b)	AOPS (b)	GSE1 (b)
EPTi	GSE1 (b)	ENC-1(b)	AOPS (b)	GSE1 (b)
CSW		Fire Party/RRT		
SKC (b)	Investigator	AOPS (b)		
ETCS (b)	Investigator	ENC (b)		
FCC (b)	Nozzleman	IT1 (b)		
GM1 (b)	Hoseman	GSE1 (b)		
MN1-1 (b)	Hoseman	IT1 (b)		
CS1 (b)				

Figure 6. Notional Blue-1 Inport Watchbill depicting Days One and Seven

D. NOTIONAL USS FREEDOM (LCS 1) UNDERWAY WATCHBILL

Typical warships get underway executing Condition III wartime cruising watchbills. In this study, underway watchstanders rotate in what is known as a "five and dime" rotation. This rotation makes the most of daylight hours by requiring that the longest watch is stood in the middle of the day while the shorter watches are stood during a person's normal sleeping hours. A notional Condition III watchbill is shown in Figure 7.

Condition III					
WATCH-STATION	Section I	Section 2	Section 3	Section I	Section 2
WATCH-HOURS	0300-0700	0700-1200	1200-1800	1800-2200	2200-0300
OOD	AOPS	EVD	MPA	AOPS	EVD
JOD	QMC	BMC	QMC	QMC	BMC
ROO	GSE1	ENCS	DOC	GSE1	ENCS
EPT	ENG-1	GSM2	EM1	ENG-1	GSM2
TAO	CHENG	OPS	CSO	CHENG	OPS
FNS	OSC-1	OSC-2	OS1	OSC-1	OSC-2
DSO	ETCS	FC1	FC2	ETCS	FC1
TSC	IT1-1	ET1	IT1-2	IT1-1	ET1
COM	FOC	ET2-1	ET2-2	FOC	ET2-1
ACT	OSC-1	OSC-2	OS1	OSC-1	OSC-2

Figure 7. Notional Condition III Five and Dime Watch Rotation with LCS crewmembers

VII. DATA AND METHODOLOGY

A. CREWMEMBER POSITIONS AND EVOLUTIONS

Each crewmember assigned to the seaframe will be an integral asset to the completion of the Continuous Certification Requirements (CCRs). In the model, these requirements are considered evolutions and are referred by Alion consultants as Evotypes and Evotasks. When the model is run, evolutions have specified pass or fail criteria that are based upon filling certain critical positions while other evolutions run with any available personnel. Appendix A displays LCS crew complement while Appendix B defines the required assigned positions. When evolution personnel requirements are not met, the evolution either can be delayed for a specified amount of time as coded in the scenario, or can fail. If the evolution manning requirements are met, the identified crewmembers are pulled from their routine schedules and assigned to the appropriate evolution task; upon completion of the evolution, crewmembers are returned to their regularly scheduled tasks. Additionally, changes in readiness condition appropriate to the scenario are simulated and triggered at specified times.

B. EXCEL SHEETS

1. Crewmember's Sheet

This study required the development of numerous Microsoft Excel spreadsheets as part of the Total Crew Model. These sheets included the data necessary to simulate a 21-day scenario.

The first of these required is the crewmembers' data sheet. This sheet is primarily designed as a reference for the modeler. Crewmember attributes include the circphase that controls the circadian rhythm, a component of the Fatigue Degradation equation. In addition, an "available tag" allows the crewmember to be toggled "on" or "off" during the model run. All 40 crewmembers will be toggled "on". Figure 8 shows an extract of this sheet.

Billet #	Name	Prospective Watchstations	MS#	CircPhase Available		
	Department					
0001	Executive	CO-b		1	1.5	1
0002	Executive	XO-b	NAVIGATOR	2	1.5	1
0003	Executive	HM1-b	MED TECH	3	1.5	1
0004	Executive	CMDMC-b	JOD,CSW,DC,RLO,DKR,	4	1.5	1
0005	Operations	OPS-b	TAO,DC,RLO,DKR,OOD	5	1.5	1
0006	Operations	AOPS-b	OOD,DC,SAF,RCO,RLO,VBO	7	1.5	1
0007	Operations	QMC-b	JOD,CSW,DC,HCO,CST,NAV	8	1.5	1
0008	Operations	OSC-1b	TAC,ACT,DC,LKO,VBS	9	1.5	1
0009	Operations	OSC-2b	TAC,ACT,DC,LHR,VBS	10	1.5	1
0010	Operations	OS1-b	TAC,ACT,DC,CAP,LHR,	11	1.5	1
0011	Operations	BMC-b	JOD,CSW,DC,RLO,LSE,CST,R CN,SAF,BDC,	12	1.5	1
0012	Operations	MN1-1b	CSW,DC,LSE,CST,LKO, LHR,SAF,SAR,VBS	13	1.5	1
0013	Operations	MN1-2b	CSW,DC,LSE,CST,LKO, LHR,DKR,SAF,BDC,SAR,VBS	14	1.5	1
0014	Operations	IT1-1b	TSC,GFC,57M,DC,LSE,CST,LH R,	15	1.5	1
0015	Operations	IT1-2b	TSC,CSW,DC,LSE,CST,CAP, DKR	16	1.5	1
0016	Combat	CSO-b	OOD, TAO, DC,RLO,LKO	17	1.5	1
0017	Operations	EMO-b	OOD,DC,HCO,CST,NAV	6	1.5	1
0018	Combat	ETCS-b	CSM,CSW,DC,LHR	18	1.5	1
0019	Combat	ET1-b	TSC,CSW,DC,CST,LHR	19	1.5	1
0020	Combat	ET2-1b	COM,CSW,DC,CST,LKO,LHR,D KR	20	1.5	1
0021	Combat	ET2-2b	COM,CSW,DC,CST,LKO,LHR,D KR	23	1.5	1
0022	Combat	FCC-b	TAO	21	1.5	1
0023	Combat	FC1-1b	COM,CSW,DC,HCO,CST,LKO, LHR, VBO	22	1.5	1

Figure 8. Snapshot of the Crewmembers' Sheet

2. Schedules Sheet

The schedules' sheet contains a linked list of tasks, each task pointing to the next within the sequence while the last task points back to the first, establishing the foundation for the scenario sheet as shown in Figure 9. Libraries of 26 schedules were created to include rotations for inport duty sections, underway watches, duty cook schedules and non-watchstanders. Additionally, schedules for the Commanding Officer and Executive Officer were created and assigned to provide a realistic simulation using all crewmembers.

Features of the schedules' sheet include start time, end time, next (which points to the next task in the sequence), and type (a number that defines the current task performed).

Schedule#	TaskNumber	Name	Following Task	Task Start Time		Task End Time		Task Type	On Duty	Day in Schedule
			Next	StTime		EndTime		Type	Duty	SchedDay
1		Cond VWatch 09-15,03-09			Time in hrs		Time in hrs			
1	1	NormalSleep	2	0	00:00	018000	5:00:00	36	0	1
1	2	RevHyg	3	018000	5:00:00	020700	5:45:00	39	0	1
1	3	Eat	4	020700	5:45:00	022440	6:15:00	22	0	1
1	4	Sweepers	5	022440	6:15:00	024300	6:45:00	31	0	1
1	5	PersTime	6	024300	6:45:00	025140	7:00:00	34	0	1
1	6	Qtrs	7	025140	7:00:00	027000	7:30:00	21	1	1
1	7	NormlWork	8	027000	7:30:00	031500	8:45:00	32	1	1
1	8	WatchTurn	9	031500	8:45:00	032400	9:00:00	37	1	1
1	9	Watch	10	032400	9:00:00	041340	11:30:00	37	1	1
1	10	Eat	11	041340	11:30:00	044040	12:15:00	22	1	1
1	11	Watch	12	044040	12:15:00	054000	15:00:00	37	1	1
1	12	NormlWork	13	054000	15:00:00	057540	16:00:00	32	1	1
1	13	DutySecDrill	14	057540	16:00:00	061200	17:00:00	23	1	1
1	14	Eat	15	061200	17:00:00	064800	18:00:00	22	1	1
1	15	Maint	16	064800	18:00:00	075600	21:00:00	33	1	1
1	16	PersTime	17	075600	21:00:00	079140	22:00:00	34	1	1
1	17	NormalSleep	18	079140	22:00:00	086400	0:00:00	36	1	2
1	18	NormalSleep	19	0	00:00	009900	2:45:00	36	1	2
1	19	WatchTurn	20	009900	2:45:00	010800	3:00:00	37	1	2
1	20	Watch	21	010800	3:00:00	023400	6:30:00	37	1	2
1	21	Eat	22	023400	6:30:00	026100	7:15:00	22	1	2
1	22	Watch	23	026100	7:15:00	031500	8:45:00	37	1	2
1	23	NormlWork	24	031500	8:45:00	041340	11:30:00	32	0	2
1	24	PersTime	25	041340	11:30:00	043200	12:00:00	34	0	2
1	25	Eat	26	043200	12:00:00	046740	13:00:00	22	0	2
1	26	NormlWork	27	046740	13:00:00	057540	16:00:00	32	0	2
1	27	Eat	28	057540	16:00:00	061200	17:00:00	22	0	2
1	28	Maint	29	061200	17:00:00	075600	21:00:00	33	0	2
1	29	PersTime	30	075600	21:00:00	079140	22:00:00	34	0	2
1	30	NormalSleep	31	079140	22:00:00	086400	0:00:00	36	0	3

Figure 9. Snapshot of Schedules Sheet

3. Schedules Assignment Sheet

This assignment sheet contains the assignments of daily schedules to each crewmember. Schedules were assigned to each crewmember according to their inport and underway duty sections. Each crewmember is assigned three schedules based on what they would be doing under each readiness condition; Condition V, Condition III or Condition I. In each case, crewmembers would perform different scheduled tasks under each condition of readiness. Figure 10 shows an extract of the schedules assignment sheet.

BSC	MS#	BILLET TITLE	DEPT/DIV	Rate	Schedule	Schedule	Schedule
					Condition_V	Condition_III	Condition_I
					Condition_V	Condition_III	Condition_I
0001	1	CO AFLOAT CDR	Executive	1110H	6	11	26
0002	2	XO AFLOAT	Executive	1110I	7	12	26
0003	3	HOSPITAL CORPSMAN	Executive	HM1	5	13	26
0004	4	COMMAND MASTER CHIEF	Executive	CMDMC	5	8	26
0005	5	OPERATIONS OFFICER	Operations	1110J	20	9	25
0006	6	ASSIST OPERATIONS OFFICER	Operations	1110K	3	8	26
0007	7	QUARTERMASTER	Operations	QMC	22	10	26
0008	8	OPERATIONS SPECIALIST	Operations	OSC-1	3	8	26
0009	9	OPERATIONS SPECIALIST	Operations	OSC-2	5	9	26
0010	10	OPERATIONS SPECIALIST	Operations	OS1	22	10	26
0011	11	BOATSWAINS MATE	Operations	BMC	17	9	26

Figure 10. Snapshot of Schedules Assignment Sheet

4. Logic Sheet

The Logic sheet contains the position type requirements for each evolution type and tasks. The number requested (NumReq) is the maximum number of personnel in each position, rate or billet specific, desired for an evolution. The critical value (Crit) is the minimum number of personnel in each position type required to run the evolution. Certifications have several tasks that require completing. For this model, the certifications are modeled as Evotypes and their applicable tasks are modeled as Evotasks. Because the training assessments require many tasks to be completed, one logic sheet was created to accommodate frequently occurring evolutions, i.e., briefs, meetings, and physical training, while seven additional sheets contained all of the tasks associated with 14 certifications. The 3M certification has been excluded due to minimal required tasks. A snapshot of this sheet is shown in Figure 11.

	EvoType	GQ	GQ	Mtg	Mtg	SmallArmsQual	SmallArmsQual	PFA	PFA
	EvoTask	GQ	GQ	Mtg	Mtg	SmallArmsQual	SmallArmsQual	PFA	PFA
		NumReq	Crit	NumReq	Crit	NumReq	Crit	NumReq	Crit
CO	1	1	1	1	1				
XO	2	1	1	1	1				
HM	3	1	1						
OOD	4	1	1						
JOD	5	1	1						
RCO	6	1	1						
EPT	7	1	1						
TAO	8	1	1						
FNS	9	1	1						
DSO	10	1	1						
TSC	11	1	1						
COM	12	1	1						
ACT	13	1	1						
GFC	14	2	2						
FIFTY7M	15	1	1						
CSW	16	7	5						
DC	17	7	5						
RLO	18	1	1						
HCO	19								
LSE	20								
CST	21								
CCO	22								
NAV	23								
LKO	24	2	2						
CAP	25								

Figure 11. Snapshot of Logic Sheet

5. Resource Sheet

The Resource Sheet is analogous to the WQ&SB. It also works hand in hand with the Logic sheets. Position titles are assigned qualified crewmembers for every evolution. Therefore, each evolution has a personnel requirement need that is satisfied by the selection and assignment of the appropriate qualified crewmembers to perform these specific tasks.

BSC	MS #	BILLET TITLE	Rate	Baseling Inport Watch Position	Baseline Watch Position (condition 3)		GQ	Mtg
				Watch	Watch	Watch	GQ	Mtg
							GQ	Mtg
0001	1	CO AFLOAT CDR	1110H				CO	CO
0002	2	XO AFLOAT	1110I				XO	XO
0003	3	HOSPITAL CORPSMAN	HM1				CSW	
0004	4	COMMAND MASTER CHIEF	CMDMC		JOD		JOD	CMDMC
0005	5	OPERATIONS OFFICER	1110J	CDO	TAO			OPS
0006	6	ASSIST OPERATIONS OFFICER	1110K	RCOi	OOD		OOD	
0007	7	QUARTERMASTER	QMC	OODi	JOD		DC	
0008	8	OPERATIONS SPECIALIST	OSC-1	OODi	TAC		FNS	OS
0009	9	OPERATIONS SPECIALIST	OSC-2		TAC		ACT	
0010	10	OPERATIONS SPECIALIST	OS1	POW	TAC		LKO	
0011	11	BOATSWAINS MATE	BMC	OODi	JOD		RLO	
0012	12	MINEKEEPER	MN1-1	POW			LKO	
0013	13	MINEKEEPER	MN1-2				CSW	
0014	14	INFORMATION SYSTEMS TECHNICIAN	IT1-1	POW	TSC		TSC	
0015	15	INFORMATION SYSTEMS TECHNICIAN	IT1-2	OODi	TSC		FIFTY7M	
0016	16	COMBAT SYSTEMS OFFICER	1110I	CDO	TAO		TAO	CSO
0017	17	ELECTRONICS MATERIAL OFFICER	1605	OODi	OOD			
0018	18	ELECTRONICS TECHNICIAN	ETCS	OODi	DSO		DSO	ET
0019	19	ELECTRONICS TECHNICIAN	ET1	POW	TSC		DC	
0020	20	ELECTRONICS TECHNICIAN	ET2-1	POW	COM		DC	
0021	21	ELECTRONICS TECHNICIAN	ET2-2	POW	COM		DC	
0022	22	FIRE CONTROLMAN	FCC	POW	COM		COM	
0023	23	FIRE CONTROLMAN	FC1	POW	CSM		CSW	
0024	24	FIRE CONTROLMAN	FC2	POW	CSM		DC	
0025	25	GUNNER'S MATE	GMC	OODi	GFC		GFC	
0026	26	GUNNER'S MATE	GM1	EPTi	GFC		GFC	
0027	27	CHIEF ENGINEER	6130	CDO	TAO			CHENG
0028	28	MAIN PROPULSION ASSIST	1110J	OODi	OOD		DC	

Figure 12. Snapshot of Resource Sheet

6. Scenario Sheet

The scenario sheet is a sequential list of all evolutions and readiness condition changes that occur during the specified simulation time as shown in Figure 13. In this analysis, time is coded in seconds to represent a 24-hour, 21 day run. Each evolution requires a start time, duration and other attributes to control the specific characteristics of the evolutions. The readiness condition changes trigger daily routine changes – specifically, crewmember watch rotations.

		EvoTask	EvoType	EvoStart	
1	Model Starting Mode	Condition_V	Condition_V	0	1
2	Crew Quarters	Qtrrs	Qtrrs	25200	1
3	Crew Training	Trng	Trng	28800	1
4	DeptBrief(s)	DeptBrief	Brief	28800	1
5	Small Arms Requal	SmallArmsQual	SmallArmsQual	32400	1
6	Daily/Liberty Meeting	Mtg	Mtg	57600	1
7	Duty Section Drills	DutySectOne	DutySecDrill	58680	1
8	Crew Quarters	Qtrrs	Qtrrs	111600	2
9	GMT	Trng	Trng	115200	2
10	DeptBrief(s)	DeptBrief	Brief	115200	2
11	CombatInsp	CSInsp	Inspections	133200	2
12	CO/XO Walkthru	Walkthru	Walkthru	141480	2
13	Daily/Liberty Meeting	Mtg	Mtg	144000	2
14	Duty Section Drills	DutySectTwo	DutySecDrill	145080	2
15	Crew Quarters	Qtrrs	Qtrrs	198000	3
16	PFA	PFA	PFA	205200	3
17	DeptBrief(s)	DeptBrief	Brief	219600	3
18	Eng/Sup Inspection	ENGSUPInsp	Inspections	219600	3
19	CO/XO Walkthru	Walkthru	Walkthru	227880	3
20	Daily/Liberty Meeting	Mtg	Mtg	230400	3
21	Duty Section Drills	DutySectThree	DutySecDrill	231480	3
22	Crew Quarters	Qtrrs	Qtrrs	284400	4
23	Med/Dental	MedDen	MedDen	291600	4
24	DeptBrief(s)	DeptBrief	Brief	291600	4
25	Ops Inspection	OPSInsp	Inspections	306000	4
26	CO/XO Walkthru	Walkthru	Walkthru	314280	4
27	Daily/Liberty Meeting	Mtg	Mtg	316800	4
28	Duty Section Drills	DutySectOne	DutySecDrill	317880	4
29	Crew Quarters	Qtrrs	Qtrrs	370800	5
30	GMT	Trng	Trng	374400	5
31	DeptBrief(s)	DeptBrief	Brief	374400	5
32	Small Arms Requal	SmallArmsQual	SmallArmsQual	392400	5
33	CO/XO Walkthru	Walkthru	Walkthru	400680	5
34	Daily/Liberty Meeting	Mtg	Mtg	403200	5
35	Duty Section Drills	DutySectTwo	DutySecDrill	404280	5
36	Crew Quarters	Qtrrs	Qtrrs	457200	6
37	DeptBrief(s)	DeptBrief	Brief	464400	6
38	FRTF Brief(s)	FRTFBrief	Brief	478800	6
39	CO/XO Brief	COBrief	Brief	487080	6
40	Daily/Liberty Meeting	Mtg	Mtg	489600	6
41	Duty Section Drills	DutySectThree	DutySecDrill	490680	6
42	Crew Quarters	Qtrrs	Qtrrs	543600	7

Figure 13. Snapshot of LCS Notional ULTRA-C Scenario

7. Trump and Condition Trump Matrices

Trump and Condition Trump matrices shown in Figures 14 and 15 respectively contain activities performed by crewmembers found in Appendix C, the Task Sheet. Included in both Trump matrices are daily scheduled activities and different types of evolutions that can be performed by the crew. In the Trump sheet, all individual pairwise comparisons are made between each activity that show where one activity can be interrupted or "trumped" by another. Condition Trump shows which evolutions can be performed in which condition of readiness.

Item		AbandonShip	GQ	AVCert	ATFPCert	AIRCert	CCCCert	EWCCert	FSOMCert	INTCert	MOBDCert	DSLCCert	GSCert	MOBSCert	MOBNCert	SWCert	VBSSCert	SARCCert	Detail	WatchTurn	Watch
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
AbandonShip	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GQ	2	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AVCert	3	1	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ATFPCert	4	1	1	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AIRCert	5	1	1	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CCCCert	6	1	1	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
EWCCert	7	1	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0
FSOMCert	8	1	1	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
INTCert	9	1	1	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
MOBDCert	10	1	1	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
DSLCCert	11	1	1	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
GSCert	12	1	1	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0

Figure 14. Snapshot of Trump Matrix

Item		AbandonShip	GQ	AVCert	ATFPCert	AIRCert	CCCCert	EWCCert	FSOMCert	INTCert	MOBDCert	DSLCCert	GSCert	MOBSCert	MOBNCert	SWCert	VBSSCert	SARCCert	Detail	WatchTurn	Watch	Qtrrs	Eat	DutySecDrill	Trng	Brief	Mtg	SmallArmsQual	PFA	MedDen	Inspections	Sweepers	NormWork
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	27	25	26	28	29	30	31	32
Condition 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Condition 2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Condition 3	3	0	1	1	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Figure 15. Snapshot of Condition Trump Matrix

C. METHODOLOGY

When the model is run, all crewmembers are started in their respective daily routines. Evolutions coded in the scenario are triggered at the appropriate times. These evolutions use the Resources and Logic sheet data with the Evolution Trump matrix to identify the appropriate crewmember for that evolution. All evolutions have specified pass or fail criteria that are based upon filling certain critical positions while other evolutions run with available personnel. Whenever an evolution cannot meet its prescribed manpower requirements, it either delays or fails as coded in the scenario. If evolution manning requirements are met, identified crewmembers are pulled from their routine schedules and started into the appropriate evolution task. Upon completion of evolutions, crewmembers are returned to their scheduled routine tasks. As readiness conditions are triggered at specified times, these changes alter the underlying schedules being performed by the crewmember and affect the ability of certain evolutions to be triggered.

TCM calculates fatigue estimates for each member of the crew in 15-minute increments. These estimates affect the specific behaviors of individual crewmembers. The model also recorded CCRs completed within the specified time in the scenario. Since fatigue is one factor that goes into personnel selection for evolutions, the model assumes a certain level of personnel management skill in selecting lesser-fatigued crewmembers with the same level of competency to complete the required evolution first. The results will inform the user whether the proposed training plan will be completed in the specific 14-day time period.

The results do not measure how well crewmembers performed in certifications, but whether certification tasks passed or failed.

VIII. ANALYSIS

During simulation, a record of every activity and task performed by each crewmember is documented. This allows the user to trace specific activities performed by an individual crewmember in order to uncover sources of excessive fatigue, misassignment of that crewmember for an evolution, or the failure of a certification task. Maximum fatigue levels are also recorded and allows the modeler to use fatigue estimates to determine crewmember effectiveness.

The total amount of time that each crewmember spends performing each type of activity in the simulation is annotated. An output file, the task type breakout sheet, details the total time spent performing different types of evolution i.e. standing normal watches, sleeping, eating, certification tasks, etc. These data allow for a comparison of actual times spent performing each activity to the productive hours used in a standard Navy workweek of 70 hrs.

A. MODEL OUTPUTS

The objective of this study is to analyze whether 40 crewmembers will successfully complete the required training assessment in fourteen days within an acceptable level of fatigue. In the following paragraphs, the output files explain in detail the results for one proposed scenario timeline. Realizing several scenarios may provide different outputs, assumptions are presented when necessary as to whether fatigue, certification completions, and workload will increase or decrease depending on the number

of crewmembers and tasks requiring completion. The results can produce realistic estimates of crew fatigue and total workload in the TCM model to assist in making command decisions relating to crew management.

Another contribution of TCM is the consolidated output of all successful and failed evolutions.

1. Successful Evolutions

When an evolution successfully meets its manning requirements, a record (Figure 16) of the evolution type, time and each specific crewmember that participated is captured. Using 14 certifications with MOBE divided into MOB-E (Diesel) and MOB-E (Gas Turbine) and the required tasks prior to the FRTP assessment, there were a total of 152 tasks. Consequently, the percentage of successful evolutions is 98.6%.

Days	Hours	Minutes	clock	Evolution #	Evolution Type	Number of Crewmembers Participating	Participating Crewmember Billets		
1	0	0	0	112	Qtrts	37	HOSPITAL CORPSMAN	COMMAND MASTER CHIEF	XO AFLOAT
1	7	0	25200	2	Qtrts	2	XO AFLOAT	CO AFLOAT CDR	
1	8	0	28800	3	Trng	33	ELECTRONICS TECHNICIAN	MINEKEEPER	HOSPITAL CORPSMAN
1	9	0	32400	4	DeptBrief	5	XO AFLOAT	OPERATIONS OFFICER	COMBAT SYSTEMS OFFICER
1	9	0	32400	5	SmallArmsQual	0			
1	16	0	57600	6	Mtg	9	CO AFLOAT CDR	XO AFLOAT	COMMAND MASTER CHIEF
1	16	30	59400	7	DutySectOne	11	CHIEF ENGINEER	MINEKEEPER	OPERATIONS SPECIALIST
2	7	0	111600	8	Qtrts	2	CO AFLOAT CDR	XO AFLOAT	
2	8	0	115200	9	Trng	33	CO AFLOAT CDR	OPERATIONS OFFICER	OPERATIONS SPECIALIST

Figure 16. Snapshot of FRTP Scenario Successful Evolutions to include day, time, evolution number and crewmembers who performed the evolutions

2. Failed Evolutions

Whenever an evolution cannot meet its prescribed personnel manning requirements and is either delayed, cancelled or fails a test, this record includes the specific type of evolution, the time the event occurred, and the specific position or skill types that were unable to be manned. A unique evolution number is also listed which traces the activities of an evolution. Overall, out of 152 tasks there were 3 failures and 2 cancellations.

All failures or cancellations were a result of personnel on watch. Displayed in Figure 17, the failed or interrupted evolutions, their fail times, and which crewmembers were unable to fulfill the requirement. Notably, not all failed evolutions would prevent the task from occurring in a real-world scenario. Therefore, for analysis purposes, all certifications were completed within the 14-day assessment. The LCS F RTP Failure sheet (Appendix K) shows crewmembers whose optional sleep was interrupted due to watchstanding replacements as applicable.

Evolution #	Condition	Evolution Type	FailCode	Crewmembers Not Participating
6	Condition_V	OptSleep	Interrupted	0006 - ASSIST OPERATIONS OFFICER
8	Condition_V	OptSleep	Interrupted	0008 - OPERATIONS SPECIALIST
14	Condition_V	OptSleep	Interrupted	0014 - INFORMATION SYSTEMS TECHNICIAN
36	Condition_V	OptSleep	Interrupted	0036 - GAS TURB SYS TECH ELEC
55	Condition_V	NavBrief	Failure	BMC
			Cause of Failure	BMC-WATCH
69	Condition_III	PlanAWMission	Failure	OSC_1
			Cause of Failure	OSC_1-WATCH

Figure 17. Snapshot of LCS F RTP Failures and Interrupted Sleep displaying unavailable crewmembers and crewmembers' whose sleep was interrupted

B. TCM FADE EQUATION

Fatigue, induced by sleep deprivation or inadequate sleep, has always been an important and persistent threat to operational effectiveness. The impaired ability of a crew to quickly and accurately respond to simple tasks can be seen when exhaustion is present. The impact of fatigue can be increased due to modeling future conflicts, recurrent around the clock operations and increased or reduced manpower.

A major contribution from the Total Crew Model is the introduction of an algorithm that estimates the fatigue induced by fragmented and reduced sleep typical of operational scenarios such as the F RTP that impair the effectiveness of crew performance. The Fatigue Degradation (FADE) equation predicts the current fatigue level for each crewmember of the ship at any point in the simulation as they progress through their duties and certifications. The impact of different crew configurations, different watch rotation schedules and other manning concerns can be compared and evaluated to provide a means by which to select the least fatigue degrading alternative.

The introduction of the FADE algorithm into TCM allows fatigue effects to be anticipated and fatigue-reducing strategies tested before exposing real crews to the consequences of fatigue. In a previous study (Bowen, et al, 2003), researchers found that daytime sleepiness and loss of alertness were found to occur during normal operations and were exacerbated by higher operational tempos. In general, performance effects are most likely to occur after 21-24 hours of wakefulness. The FADE equation considers the time of day (circadian) and time awake (linear) components.

These inputs are needed because human cognitive abilities as well as physiology are affected by circadian rhythmicity. All disruptions of circadian cyclicity can create psychological and physiological problems.

A parabolic recovery function is used, since shortened sleep, which occurs during sleep fragmentation, does not provide adequate rest. The equation combines the circadian component with a parabolic function to predict fatigue based upon hours awake and recovery from fatigue based upon hours slept. The FADE equation divides the results into three levels of acceptable limits. Fatigue levels below four are acceptable levels of fatigue, levels between four and six are marginally acceptable, while a fatigue index of six or greater signals an area of fatigue that represents 18 hours of wakefulness and is considered unacceptable.

Fatigue Index	Hrs of Wakefulness
4	16
5	17
6	18
7	19
8	20
9	21
10	22
11	23
12	24

Figure 18. Fatigue Index and Corresponding Waking Hours

1. Fatigue Charts

Fatigue estimates are computed and recorded for each crewmember every 15 minutes. This data is graphed to create fatigue curves that can be used to inform Commanding

Officers of crewmembers who are at risk of severe fatigue during an assessment. These fatigue values correspond to the percentage of decrement in response time, and values greater than six are considered excessive fatigue. The output from this scenario left 60% of the crew reaching unacceptable fatigue levels. Figure 19 shows crewmembers with fatigue levels over six. Figure 20 displays several crewmembers over the 21-day scenario experiencing fatigue levels over eight, indicating 20 hours of wakefulness.

MS#	Billet	Max Fatigue Level
4	HM1	6
6	AOPS	11
8	OSC-1	11
11	BMC	8
12	MN1-1	11
19	ET1	12
20	ET2-1	8
21	ET2-2	9
25	GMC	12
26	GM1	11
27	CHENG	6
28	MPA	7
29	GSM2	8
32	ENC-1	6
33	ENC-2	11
34	EN1	12
37	SKC	8

Figure 19. Crewmembers with Fatigue Level Greater Than Six - MS# is the Micro Saint number required for Total Crew Model to function

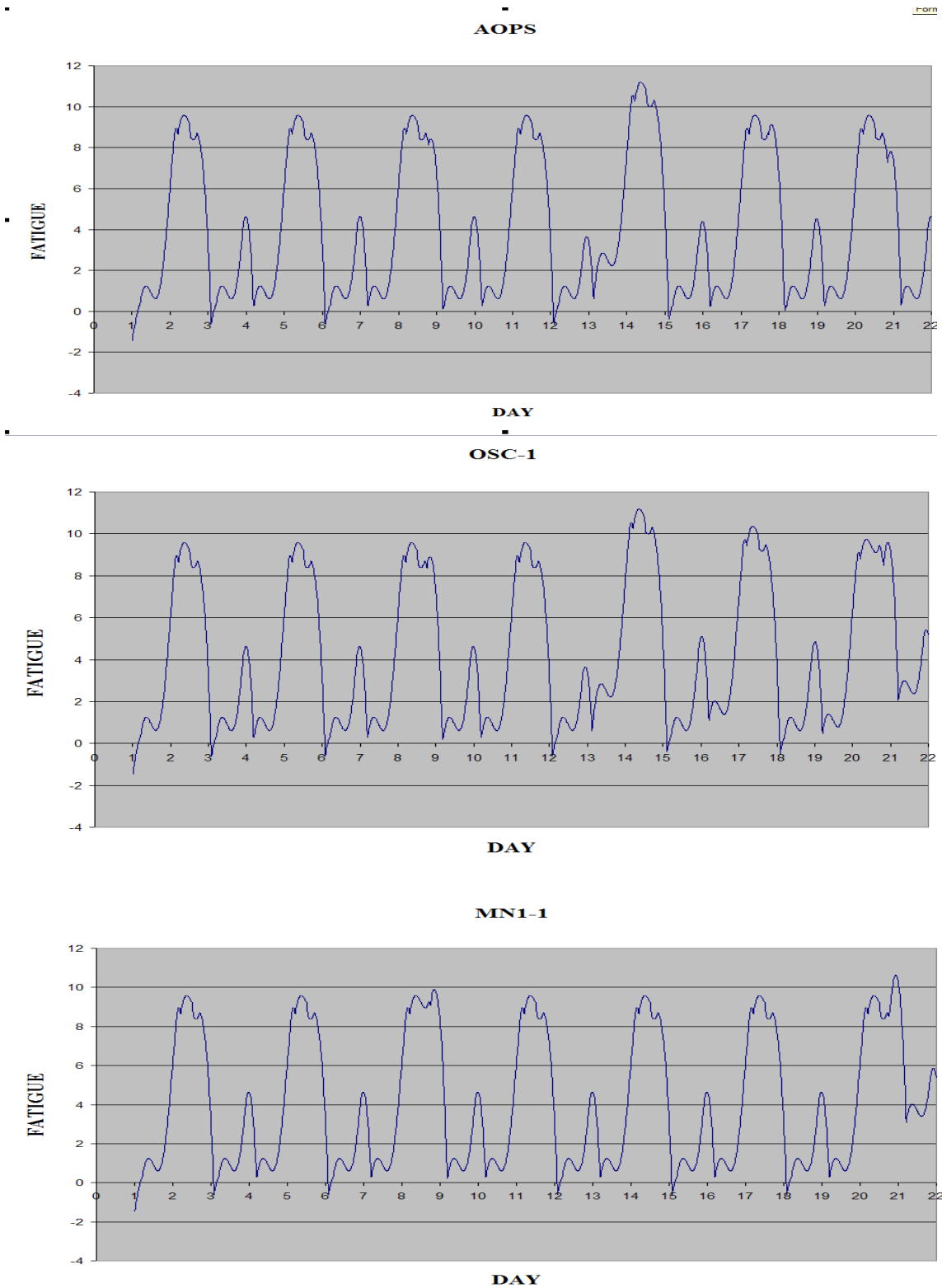


Figure 20. Individual Fatigue Charts for AOPS, MN1-1 and OSC-1 displaying maximum fatigue levels over eight

C. TASK-TYPE BREAKOUT

The Navy's standard workweeks are key elements in the calculation of Navy manpower requirements. They are guidelines for sustained personnel utilization under projected wartime or peacetime conditions and intend to reflect the limits of personnel endurance. They are for planning purposes only and are neither restrictive nor binding on commanders or commanding officer in establishing individual working hours. Daily workload intensity is a function of operational requirements, and under certain circumstances it may become necessary to extend the standard workweek.

Average weekly hours, expressed in Navy standard workweeks, serve as guidelines for sustained personnel utilization. The currently followed naval instruction, OPNAVINST 1000.16J, details several descriptions of Navy standard workweeks dependent on military personnel assigned afloat, ashore or in aircraft squadrons. For the purposes of this analysis, the standard workweek for LCS crewmembers will follow the afloat (wartime) schedule, since the F RTP is preparing the ship to independently deploy and will be at Condition III while underway. The afloat workweek assumes a unit is steaming in Condition III on a three-section watch basis. Figure 21 shows the breakdown of an afloat standard workweek with 56 hours allocated to watch stations.

AFLOAT (WARTIME) - MILITARY PERSONNEL		
	7 days	
Ship Standard Workweek		81.00
Productive Workweek		70.00
Analysis of Duty Hours		
Total hours available weekly		168.00
Less:		
Sleep	(56.00)	
Messing	(14.00)	
Personal Needs	(14.00)	
Sunday	(3.00)	(87.00)
Duty Hours per Week		81.00
Less:		
Training	(7.00)	
Service Diversion	(4.00)	(11.00)
Tot hrs avail for productive work		70.00

Figure 21. Afloat Navy Standard Work Week Breakdown

The task-type breakout sheet, shown in Figure 22, is a breakdown of hours spent by watchstanders over the 21-day scenario. Standard practices do not include training hours in Condition III, however, modeling the FRTP in this study will directly contribute to combat readiness, and is included as productive work.

	CO AFLOAT CDR	XO AFLOAT	HOSPITAL CORPSMAN	COMMAND MASTER CHIEF	OPERATIONS OFFICER
PRODUCTIVE WORK					
Avg Work Hours Each Week	69.25	69	103	98	76
Deviation from 70 Hr Work Week	-0.75	-1	33	28	6
Deviation from 67 Hr Work Week	2	2	36	31	9
Deviation from 63 Hr Work Week	7	7	40	35	13

Figure 22. Snapshot of Task Type Breakout Displaying Average Individual Work Hours Each Week

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IX. SUMMARY

A. COMPLETED TASKS

When creating the model, several runs were attempted before successful evolutions or completed tasks were displayed in the output files. Certification tasks reached high completion rates when modeled in the scenario in sequential order. In several instances when modeling the core crew only, there is only one crewmember qualified to complete a task, as is the case during the Fleet Support Operations-Medical (FSO-M) certification and having one Independent Duty Corpsman (IDC) Hospital Corpsman (HM) prevented FSO-M tasks from being assigned concurrently.

In real world scenarios, several certifications may be on going at the same time. If the ISIC and ATG have representatives available in different areas of expertise, LCS crewmembers can perform tasks from different certifications simultaneously. This scenario assumption was not modeled in this research and therefore cannot be analyzed for the same measures of performance.

B. FATIGUE LEVELS

Though 98% of the tasks within this scenario were successfully completed, fatigue levels for 42.5% of the crew reached levels considered unacceptable based on TCM's criteria. Throughout the scenario, the average fatigue levels remained between 1.8 and 4.9. However, as expected due to higher operational tempos, duty days for some crewmembers and during periods of the assessment for others, fatigue levels reached indexes as high as 12,

indicating 24 hours of wakefulness. This state of fatigue, according to studies completed by Alion Science, is associated with levels of performance decrement directly proportionally to response times experienced when performing these tasks. For example, the fatigue index of 10 indicates that an individual is predicted to be 10% slower at a task performed when that level is reached. Particularly, crewmembers reaching these levels do not realize how impaired their performance is thus potentially creating unsafe environments for themselves and their fellow crewmembers.

Commanders should be aware of crewmembers who reach dangerously high fatigue levels. As shown in Figure 23, the Individual Summary Fatigue output file indicates that 20% of LCS's core crew reached fatigue levels greater than 10, indicating 22 hours of wakefulness or two hours of sleep within a 24-hour period.

BSC	6 - 0006	8 - 0008	12 - 0012	19 - 0019	25 - 0025	26 - 0026	33 - 0033	34 - 0034
MS#	6	8	12	19	25	26	33	34
Billet	AOPS	OSC-1	MN1-1	ET1	GMC	GM1	ENC-2	EN1
Max Fatigue Level	11	11	11	12	12	11	11	12

Figure 23. Snapshot of Crewmembers With Fatigue Levels Greater than Ten

An unexpected outcome was fatigue levels for Chief Gunner's Mate (GMC) and Gunner's Mate First Class (GM1), both reaching 12 and 11 respectively. This may be attributed to the hybrid sailor concept. To facilitate

completing all special evolutions in the FRTP, TCM uses a wider assignment base to replace personnel for watches or required tasks with other qualified personnel. This level of personnel management often tasks other ratings qualified in areas outside of their job description, increasing an individual's number of tasks, and thus their fatigue level. The failure output sheet, shown in Appendix L, also indicates that while some crewmembers opted to take naps, which recovers some of their wake time, optional sleep evolutions failed and could attribute to increased fatigue levels.

C. TASK WORKLOAD

In analyzing the workweek hours, every hour above 70 in Condition III adds another manpower requirement to the Ships Manpower Document. In this study, 37 billets exceeded the 70 hour workweek by 594 hours, which equates to an additional eight personnel ($594/70$) added to the 40 member core crew. The addition of eight core crewmembers will decrease either the required 15 member mission module package or 20-member augmented aircrew to accommodate the current 75 manpower requirement for the Littoral Combat Ship.

D. CONCLUSIONS

The currently proposed training plan has been created for both blue and gold crews to certify simultaneously. This study only models the blue core crewmembers in ULTRA-C.

The additional 40 personnel standing inport watches and providing own unit support (OUS) evolutions in this scenario should expect fatigue levels to decrease for individual crewmembers based on the data. Both crews assigned to the LCS will deploy independently of each other. Consequently, these additional 40 personnel inport will double the tasks, since both crews must show proficiencies in all certifications prior to deploying. Minimizing crew fatigue levels during the actual assessment will not be achievable; however, knowing potential maximum fatigue levels for each crewmember will allow Commanding Officers to manage crew rest periods during the actual assessment.

Commanding Officers will have to complete all tasks required for the FRTP. The Littoral Combat Ship is expected to extend our naval reach into littoral waters which is becoming increasingly important against the global war on terror. During operational deployments and training exercises either alone or with a battle group, the crew is anticipated to be combat ready at all times. Fatigue is inevitable and longer work hours are expected. However, understanding the risk of excessive and prolonged fatigue levels caused by longer hours and an increased workload will aid a Commanding Officer in managing personnel most affected during this scenario.

LCS's augmented mission module crew of 15 and an aircrew of 20 must have its fully developed manpower requirements onboard. Moreover, along with the 15 certifications required from the core crew, the additional certification required from the augmented crews will

include Mine Warfare (MIW). There will be more crewmembers who are qualified for damage control and seamanship evolutions and can provide additional own unit support in various conditions, perhaps reducing high fatigue levels and reducing total weekly workload hours.

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X. FINDINGS

The research found that TCM can model and analyze a host of different scenarios resulting in different proposals to continuously update LCS program managers. The following findings are results from scenarios specifically run for this thesis.

A. PROJECTED OUTCOME OF AN LCS FRTP

The Total Crew Model was successful in predicting the outcome of the FRTP used in this scenario. This thesis validated not only the manpower requirements for the LCS but also the output results from TCM. It is recommended that the use of TCM be extended to Commanding Officers and their training representatives. This will enable TYCOMs, ISICs and ship's company be aware of possible problem areas before executing large scale task scenarios in support of reduced manning and increasingly automated and highly technologically advanced warships

B. CAPABILITIES AND LIMITATIONS OF MINIMAL MANNING ONBOARD THE LCS

Conducting this research brought forth other questions regarding capabilities and limitations of minimal manning aboard the LCS. While the adaptation of the hybrid sailor increases an individual's capabilities, it lends itself to a limitation (high fatigue levels) of minimally manning a warship. Understanding this limitation, LCS leaders will have to develop ways of mitigating these limits to facilitate consistent safe operations afloat. Operational tempos for the LCS are expecting deployments every three

months after certifications are completed. Utilizing the current program of crew swap, decision makers are exploring the effects of a blue/gold crew swap similar to the submarine community's practice with the seaframe on station for six months and the crew swapping every three months.

XI. FUTURE RECOMMENDED RESEARCH

A. FATIGUE ANALYSIS OF UNDERWAY OPERATIONS WITH TEN PERCENT DECREASE IN PERSONNEL

LCS is designed to have the capability to replace a Human Capital Object position number for number. Another challenge that the proponents of LCS will have to face is the possibility of losing more than one crewmember in an operational environment. How will crew performance be affected with decreased manpower? Using TCM, model a three-month deployment with a ten percent decrease in total manpower requirements.

B. COST BENEFIT ANALYSIS ON LCS MANPOWER SEA BASING

Currently Sea Basing is designed to allow positioning networked joint forces for immediate employability as well as enhancing maneuver ashore by reducing the need to continuously relocate major command and control elements, heavy fire support systems, or logistical supplies. Though this study addresses the effects of manpower on the life cycle costs for naval ships, the optimal manning concept should be reviewed by manpower analysts such as the Navy Manpower Analysis Center (NAVMAC) to examine the dollar cost effect of replacing LCS Human Capital Object personnel Outer Continental United States (OCONUS). The examination should include theater travel time and personnel gaps while supporting the forward deployed LCSs.

C. WATCH SECTION ROTATION

Conduct further research into alternative watchstanding rotations such as "five and dime". The data

shows regular circadian rest increases a crewmembers cognitive capability there warfighting capability. Watch rotation policy should be incorporated into the LCS Ships Organization and Regulation Manual (SORM).

APPENDIX A. LCS FRTP CREWMEMBERS

BILLET TITLE	Rate	Department
CO AFLOAT CDR	1110H	Executive
XO AFLOAT	1110I	Executive
HOSPITAL CORPSMAN	HM1	Executive
COMMAND MASTER CHIEF	CMDMC	Executive
OPERATIONS OFFICER	1110J	Operations
ASSIST OPERATIONS OFFICER	1110K	Operations
QUARTERMASTER	QMC	Operations
OPERATIONS SPECIALIST	OSC-1	Operations
OPERATIONS SPECIALIST	OSC-2	Operations
OPERATIONS SPECIALIST	OS1	Operations
BOATSWAINS MATE	MC	Operations
MINEKEEPER	MN1-1	Operations
MINEKEEPER	MN1-2	Operations
INFORMATION SYSTEMS TECHNICIAN	IT1-1	Operations
INFORMATION SYSTEMS TECHNICIAN	IT1-2	Operations
COMBAT SYSTEMS OFFICER	1110I	Combat
ELECTRONICS MATERIAL OFFICER	1605	Operations
ELECTRONICS TECHNICIAN	ETCS	Combat
ELECTRONICS TECHNICIAN	ET1	Combat
ELECTRONICS TECHNICIAN	ET2-1	Combat
ELECTRONICS TECHNICIAN	ET2-2	Combat
FIRE CONTROLMAN	FCC	Combat
FIRE CONTROLMAN	FC1	Combat
FIRE CONTROLMAN	FC2	Combat
GUNNER'S MATE	GMC	Combat
GUNNER'S MATE	GM1	Combat
CHIEF ENGINEER	6130	Engineering
MAIN PROPULSION ASSIST	1110J	Engineering
GAS TURB SYS TECH MECH	GSM2	Engineering
ELECTRICIAN'S MATE	EM1	Engineering
ENGINEMAN	ENCS	Engineering
ENGINEMAN	ENC-1	Engineering
ENGINEMAN	ENC-2	Engineering
ENGINEMAN	EN1	Engineering
DAMAGE CONTROLMAN	DCC	Engineering
GAS TURB SYS TECH ELEC	GSE1	Engineering
STOREKEEPER	SKC	Supply
CULINARY SPECIALIST	CS1	Supply
CULINARY SPECIALIST	CS2-1	Supply
CULINARY SPECIALIST	CS2-2	Supply

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APPENDIX B. LCS GLOSSARY OF POSITIONS

P	PRIMARY WATCHSTANDER ASSIGNMENT	
A	ALTERNATE WATCHSTANDER	Added to provide CO watchbill flexibility
OOD	OFFICER OF THE DECK UNDERWAY	Unique to LCS Class ships
JOD	JUNIOR OFFICER OF THE DECK	Unique to LCS Class ships
RCO	READINESS CONTROL OFFICER	
EPT	ENGINEERING PLANT TECHNICIAN	
TAO	TACTICAL ACTION OFFICER	
FNS	FORCE NET SUPERVISOR	LCS-1 Class only
TAC	TACTICAL AWARENESS COMMUNICATOR	LCS-2 Class only
DSO	DEFENSE SYSTEMS OPERATOR	LCS-1 Class only
CSM	COMBAT SYSTEMS MANAGER	LCS-2 Class only
TSC	TOTAL SHIPS COMPUTING ENVIRONMENT OPERATOR	
COM	COMMUNICATIONS TECHNICIAN	
ACT	AIR CONTROL TECHNICIAN	Also known as ASTAC
GFC	GUN FIRE CONTROL SYSTEM TECHNICIAN	
57M	57 MM GUN LOADER	
CSW	CREW-SERVED WEAPONS GUNNER	Includes 25mm, .50cal, Shotgun, M16, and M9
DC	DAMAGE CONTROL TEAM MEMBER	Includes all positions from Utilityman to On-Scene Leader (313 qualified)
RLO	REPAIR LOCKER OFFICER	Includes all RLOs (IET and DCRS) and DCA (when assigned)
HCO	HELO CONTROL OFFICER	
LSE	LANDING SIGNALMAN ENLISTED	Includes all CST requirements
CST	CRASH AND SALVAGE TEAM	
CCO	CHOCK & CHAIN OPERATOR	Includes all CST requirements
NAV	NAVIGATION EVALUATOR	Executive Officer will usually be on the bridge for Cond II Nav situations
LKO	LOOKOUT	Includes Low Visibility detail Lookouts
CAP	CAPSTAN OPERATOR	Includes Anchoring and Mooring Evolutions
LHR	LINE HANDLER	Includes all Line Handling evolutions (Mooring, RAS, Launch & Recovery)
RCN	RIG CAPTAIN	
WOR	WINCH & CRANE OPERATOR	Includes Launch & Recovery and TRIGON
SPO	SLIDING PADEYE OPERATOR	
DKR	DECK RIGGER	
SAF	DECK SAFETY OFFICER	
BDC	BOAT DAVIT CAPTAIN	
BDO	BOAT DAVIT OPERATOR	
BCX	BOAT COXSWAIN	
BEN	BOAT ENGINEER	
SAR	SEARCH & RESCUE SWIMMER	
VBO	VBSS BOARDING OFFICER	
VBS	VBSS BOARDING TEAM MEMBER	
CDO	COMMNAV DUTY OFFICER	
OODi	OFFICER OF THE DECK INPORT	
POW	PETTY OFFICER OF THE WATCH	
CSW	CREW-SERVED WEAPONS GUNNER	Includes 25mm, .50cal, Shotgun, M16, and M9
GUN	ATFP GUN OPERATOR	Includes Shotgun, M16, and M9 (Rovers & Sentries)
EDO	ENGINEERING DUTY OFFICER	(RCO Qualified)
EPT	ENGINEERING PLANT TECHNICIAN	
RLO	IET REPAIR LOCKER OFFICER	
DC	DAMAGE CONTROL TEAM MEMBER	Includes all positions from Utilityman to On-Scene Leader (313 qualified)

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APPENDIX C. LCS FRTP TASK DATA

Type #	Description	Model Constants	Micro Saint Task #	Is this a Special Evolution?	Is this a Sleep task?	Should a crewmember be replaced?	Can you forego this task to take optional sleep?
			TaskNumber		Sleep	Replace	Nap
1	AbandonShip	AbandonShip	15001	1			
2	GQ	GQ	15001	1			
3	AVCert	AVCert	15001	1			
4	ATFPCert	ATFPCert	15001	1			
5	AIRCert	AIRCert	15001	1			
6	CCCCert	CCCCert	15001	1			
7	EWCert	EWCert	15001	1			
8	FSOMCert	FSOMCert	15001	1			
9	INTCert	INTCert	15001	1			
10	MOBDCert	MOBDCert	15001	1			
11	DSLCCert	DSLCCert	15001	1			
12	GSCert	GSCert	15001	1			
13	MOBSCert	MOBSCert	15001	1			
14	MOBNCert	MOBNCert	15001	1			
15	SWCert	SWCert	15001	1			
16	VBSSCert	VBSSCert	15001	1			
17	SARCert	SARCert	15001	1			
18	Detail	Detail	15001	1			
19	WatchTurn	WatchTurn	15001				
20	Watch	Watch	15001			1	
21	Qtrts	Qtrts	15001				
22	Eat	Eat	15001				1
23	DutySecDrill	DutySecDrill	15001				
24	Trng	Trng	15001				
25	Brief	Brief	15001				
26	Mtg	Mtg	15001				
27	SmallArmsQual	SmallArmsQual	15001	1			
28	PFA	PFA	15001	1			
29	MedDen	MedDen	15001	1			
30	Inspection	Inspection	15001	1			
31	Sweepers	Sweepers	15001				
32	NormWork	NormWork	15001				
33	Maint	Maint	15001				
34	PersTime	PersTime	15001				1
35	DutyCook	DutyCook	15001				
36	NormalSleep	NormalSleep	15001		1		
37	Walkthru	Walkthru	15001				
38	AdWork	AdWork	15001				
39	RevHyg	RevHyg	15001				
40	DivineSer	DivineSer	15001				1
41	OptSleep	OptSleep	15001		1		
42	Liberty	Liberty	15001				1

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APPENDIX D. LCS FRTP SCHEDULES SHEET

Schedule #	TaskNumber	Name	Following Task	Task Start Time			Task End Time			Task Type	On Duty	Day in Schedule	TotalDays in Schedule	Start Time	End Time
			Next	StTime			EndTime			Type	Duty	SchedDay	TotSchedDays		
1		Cond V Section 1 (09-15,03-09)				Time in hrs		Time in hrs							
1	1	NormalSleep	2	0	0	0.00	18000	18000	5.00	NormalSleep	0	1	3	0:00	5:00
1	2	RevHyg	3	18000	18000	5.00	20700	2700	5.75	RevHyg	0	1	3	5:00	5:45
1	3	Eat	4	20700	20700	5.75	22500	1800	6.25	Eat	0	1	3	5:45	6:15
1	4	Sweepers	5	22500	22500	6.25	24300	1800	6.75	Sweepers	0	1	3	6:15	6:45
1	5	PersTime	6	24300	24300	6.75	25200	900	7.00	PersTime	0	1	3	6:45	7:00
1	6	Qtrts	7	25200	25200	7.00	27000	1800	7.50	Qtrts	1	1	3	7:00	7:30
1	7	NormWork	8	27000	27000	7.50	31500	4500	8.75	NormWork	1	1	3	7:30	8:45
1	8	WatchTurn	9	31500	31500	8.75	32400	900	9.00	WatchTurn	1	1	3	8:45	9:00
1	9	Watch	10	32400	32400	9.00	41400	9000	11.50	Watch	1	1	3	9:00	11:30
1	10	Eat	11	41400	41400	11.50	44100	2700	12.25	Eat	1	1	3	11:30	12:15
1	11	Watch	12	44100	44100	12.25	54000	9900	15.00	Watch	1	1	3	12:15	15:00
1	12	NormWork	13	54000	54000	15.00	63000	9000	17.50	NormWork	1	1	3	15:00	17:30
1	13	Eat	14	63000	63000	17.50	64800	1800	18.00	Eat	1	1	3	17:30	18:00
1	14	Maint	15	64800	64800	18.00	75600	10800	21.00	Maint	1	1	3	18:00	21:00
1	15	PersTime	16	75600	75600	21.00	79200	3600	22.00	PersTime	1	1	3	21:00	22:00
1	16	NormalSleep	17	79200	79200	22.00	86400	7200	24.00	NormalSleep	1	1	3	22:00	0:00
1	17	NormalSleep	18	0	86400	0.00	9900	9900	2.75	NormalSleep	1	2	3	0:00	2:45
1	18	WatchTurn	19	9900	96300	2.75	10800	900	3.00	WatchTurn	1	2	3	2:45	3:00
1	19	Watch	20	10800	97200	3.00	23400	12600	6.50	Watch	1	2	3	3:00	6:30
1	20	Eat	21	23400	109800	6.50	26100	2700	7.25	Eat	1	2	3	6:30	7:15
1	21	Watch	22	26100	112500	7.25	32400	6300	9.00	Watch	1	2	3	7:15	9:00
1	22	NormWork	23	32400	118800	9.00	41400	9000	11.50	NormWork	0	2	3	9:00	11:30
1	23	PersTime	24	41400	127800	11.50	43200	1800	12.00	PersTime	0	2	3	11:30	12:00
1	24	Eat	25	43200	129600	12.00	46800	3600	13.00	Eat	0	2	3	12:00	13:00
1	25	NormWork	26	46800	133200	13.00	57600	10800	16.00	NormWork	0	2	3	13:00	16:00
1	26	Eat	27	57600	144000	16.00	61200	3600	17.00	Eat	0	2	3	16:00	17:00
1	27	Liberty	28	61200	147600	17.00	79200	18000	22.00	Liberty	0	2	3	17:00	22:00
1	28	NormalSleep	29	79200	165600	22.00	86400	7200	24.00	NormalSleep	0	2	3	22:00	0:00
1	29	NormalSleep	30	0	172800	0.00	18000	18000	5.00	NormalSleep	0	3	3	0:00	5:00
1	30	RevHyg	31	18000	190800	5.00	20700	2700	5.75	RevHyg	0	3	3	5:00	5:45
1	31	Eat	32	20700	193500	5.75	22500	1800	6.25	Eat	0	3	3	5:45	6:15
1	32	Sweepers	33	22500	195300	6.25	24300	1800	6.75	Sweepers	0	3	3	6:15	6:45
1	33	PersTime	34	24300	197100	6.75	25200	900	7.00	PersTime	0	3	3	6:45	7:00
1	34	Qtrts	35	25200	198900	7.00	27000	1800	7.50	Qtrts	0	3	3	7:00	7:30
1	35	NormWork	36	27000	199800	7.50	41400	14400	11.50	NormWork	0	3	3	7:30	11:30
1	36	Eat	37	41400	214200	11.50	46800	5400	13.00	Eat	0	3	3	11:30	13:00
1	37	NormWork	38	46800	219600	13.00	61200	14400	17.00	NormWork	0	3	3	13:00	17:00
1	38	Liberty	39	61200	234000	17.00	79200	18000	22.00	Liberty	0	3	3	17:00	22:00
1	39	NormalSleep	1	79200	252000	22.00	86400	7200	24.00	NormalSleep	0	3	3	22:00	0:00
2		Cond V Section 1 (15-21)													
2	1	NormalSleep	2	0	0	0.00	18000	18000	5.00	NormalSleep	0	1	3	0:00	5:00
2	2	RevHyg	3	18000	18000	5.00	20700	2700	5.75	RevHyg	0	1	3	5:00	5:45
2	3	Eat	4	20700	20700	5.75	22500	1800	6.25	Eat	0	1	3	5:45	6:15
2	4	Sweepers	5	22500	22500	6.25	24300	1800	6.75	Sweepers	0	1	3	6:15	6:45
2	5	PersTime	6	24300	24300	6.75	25200	900	7.00	PersTime	0	1	3	6:45	7:00
2	6	Qtrts	7	25200	25200	7.00	27000	1800	7.50	Qtrts	1	1	3	7:00	7:30
2	7	NormWork	8	27000	27000	7.50	41400	14400	11.50	NormWork	1	1	3	7:30	11:30
2	8	Eat	9	41400	41400	11.50	46800	5400	13.00	Eat	1	1	3	11:30	13:00
2	9	NormWork	10	46800	46800	13.00	53100	6300	14.75	NormWork	1	1	3	13:00	14:45
2	10	WatchTurn	11	53100	53100	14.75	54000	900	15.00	WatchTurn	1	1	3	14:45	15:00
2	11	Watch	12	54000	54000	15.00	61200	7200	17.00	Watch	1	1	3	15:00	17:00
2	12	Eat	13	61200	61200	17.00	64800	3600	18.00	Eat	1	1	3	17:00	18:00
2	13	Watch	14	64800	64800	18.00	75600	10800	21.00	Watch	1	1	3	18:00	21:00
2	14	PersTime	15	75600	75600	21.00	79200	3600	22.00	PersTime	1	1	3	21:00	22:00
2	15	NormalSleep	16	79200	79200	22.00	86400	7200	24.00	NormalSleep	1	1	3	22:00	0:00
2	16	NormalSleep	17	0	86400	0.00	18000	18000	5.00	NormalSleep	1	2	3	0:00	5:00
2	17	RevHyg	18	18000	104400	5.00	20700	2700	5.75	RevHyg	1	2	3	5:00	5:45
2	18	Eat	19	20700	107100	5.75	22500	1800	6.25	Eat	1	2	3	5:45	6:15
2	19	Sweepers	20	22500	108900	6.25	24300	1800	6.75	Sweepers	1	2	3	6:15	6:45
2	20	PersTime	21	24300	110700	6.75	25200	900	7.00	PersTime	1	2	3	6:45	7:00
2	21	Qtrts	22	25200	111600	7.00	27000	1800	7.50	Qtrts	0	2	3	7:00	7:30
2	22	NormWork	23	27000	113400	7.50	41400	14400	11.50	NormWork	0	2	3	7:30	11:30
2	23	PersTime	24	41400	127800	11.50	43200	1800	12.00	PersTime	0	2	3	11:30	12:00
2	24	Eat	25	43200	129600	12.00	46800	3600	13.00	Eat	0	2	3	12:00	13:00
2	25	NormWork	26	46800	133200	13.00	61200	14400	17.00	NormWork	0	2	3	13:00	17:00
2	26	Liberty	27	61200	147600	17.00	79200	18000	22.00	Liberty	0	2	3	17:00	22:00
2	27	NormalSleep	28	79200	165600	22.00	86400	7200	24.00	NormalSleep	0	2	3	22:00	0:00
2	28	NormalSleep	29	0	172800	0.00	18000	18000	5.00	NormalSleep	0	3	3	0:00	5:00
2	29	RevHyg	30	18000	190800	5.00	20700	2700	5.75	RevHyg	0	3	3	5:00	5:45
2	30	Eat	31	20700	193500	5.75	22500	1800	6.25	Eat	0	3	3	5:45	6:15
2	31	Sweepers	32	22500	195300	6.25	24300	1800	6.75	Sweepers	0	3	3	6:15	6:45
2	32	PersTime	33	24300	197100	6.75	25200	900	7.00	PersTime	0	3	3	6:45	7:00
2	33	Qtrts	34	25200	198900	7.00	27000	1800	7.50	Qtrts	0	3	3	7:00	7:30
2	34	NormWork	35	27000	199800	7.50	41400	14400	11.50	NormWork	0	3	3	7:30	11:30
2	35	Eat	36	41400	214200	11.50	46800	5400	13.00	Eat	0	3	3	11:30	13:00
2	36	NormWork	37	46800	219600	13.00	61200	14400	17.00	NormWork	0	3	3	13:00	17:00
2	37	Liberty	38	61200	234000	17.00	79200	18000	22.00	Liberty	0	3	3	17:00	22:00
2	38	NormalSleep	1	79200	252000	22.00	86400	7200	24.00	NormalSleep	0	3	3	22:00	0:00

APPENDIX E. LCS FRTP SCHED ASSIGNMENTS

BSC	MS#	BILLET TITLE	DEPT/DIV	Rate	Schedule	Schedule	Schedule
					Condition_V	Condition_III	Condition_I
					Condition_V	Condition_III	Condition_I
0001	1	CO AFLOAT CDR	Executive	1110H	6	11	26
0002	2	XO AFLOAT	Executive	1110I	7	12	26
0003	3	HOSPITAL CORPSMAN	Executive	HM1	5	13	26
0004	4	COMMAND MASTER CHIEF	Executive	CMDMC	5	8	26
0005	5	OPERATIONS OFFICER	Operations	1110J	20	9	25
0006	6	ASSIST OPERATIONS OFFICER	Operations	1110K	3	8	26
0007	7	QUARTERMASTER	Operations	QMC	22	10	26
0008	8	OPERATIONS SPECIALIST	Operations	OSC-1	3	8	26
0009	9	OPERATIONS SPECIALIST	Operations	OSC-2	5	9	26
0010	10	OPERATIONS SPECIALIST	Operations	OS1	22	10	26
0011	11	BOATSWAINS MATE	Operations	BMC	17	9	26
0012	12	MINEKEEPER	Operations	MN1-1	3	13	26
0013	13	MINEKEEPER	Operations	MN1-2	5	13	26
0014	14	INFORMATION SYSTEMS TECHNICIAN	Operations	IT1-1	1	8	26
0015	15	INFORMATION SYSTEMS TECHNICIAN	Operations	IT1-2	21	10	26
0016	16	COMBAT SYSTEMS OFFICER	Combat	1110I	24	10	26
0017	17	ELECTRONICS MATERIAL OFFICER	Combat	1605	18	9	25
0018	18	ELECTRONICS TECHNICIAN	Combat	ETCS	2	8	26
0019	19	ELECTRONICS TECHNICIAN	Combat	ET1	19	9	26
0020	20	ELECTRONICS TECHNICIAN	Combat	ET2-1	17	9	26
0021	21	ELECTRONICS TECHNICIAN	Combat	ET2-2	23	10	26
0022	22	FIRE CONTROLMAN	Combat	FCC	2	8	26
0023	23	FIRE CONTROLMAN	Combat	FC1	18	9	26
0024	24	FIRE CONTROLMAN	Combat	FC2	21	10	26
0025	25	GUNNER'S MATE	Combat	GMC	19	13	26
0026	26	GUNNER'S MATE	Combat	GM1	3	13	26
0027	27	CHIEF ENGINEER	Engineering	6130	4	8	26
0028	28	MAIN PROPULSION ASSIST	Engineering	1110J	23	10	26
0029	29	GAS TURB SYS TECH MECH	Engineering	GSM2	17	9	26
0030	30	ELECTRICIAN'S MATE	Engineering	EM1	21	10	26
0031	31	ENGINEMAN	Engineering	ENCS	18	9	26
0032	32	ENGINEMAN	Engineering	ENC-1	5	8	26
0033	33	ENGINEMAN	Engineering	ENC-2	23	13	26
0034	34	ENGINEMAN	Engineering	EN1	19	13	26
0035	35	DAMAGE CONTROLMAN	Engineering	DCC	22	10	26
0036	36	GAS TURB SYS TECH ELEC	Engineering	GSE1	1	8	26
0037	37	STOREKEEPER	Supply	SKC	1	13	26
0038	38	CULINARY SPECIALIST	Supply	CS1	14	13	26
0039	39	CULINARY SPECIALIST	Supply	CS2-1	15	13	26
0040	40	CULINARY SPECIALIST	Supply	CS2-2	16	13	26

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APPENDIX F. LCS LOGIC DATA

	EvoType	GQ	GQ	Mtg	Mtg	SmallArmsQual	SmallArmsQual	PFA	PFA	MedDen	MedDen
	EvoTask	GQ	GQ	Mtg	Mtg	SmallArmsQual	SmallArmsQual	PFA	PFA	MedDen	MedDen
		NumReq	Crit	NumReq	Crit	NumReq	Crit	NumReq	Crit	NumReq	Crit
GetAll	1					1		1		1	
CO	2	1	1	1	1						
XO	3	1	1	1	1						
HM1	4		1								
CMDMC	5			1	1						
OPS	6			1	1						
AOPS	7										
QMC	8										
OSC_1	9			1							
OSC_2	10										
OS1	11										
BMC	12										
MN1_1	13										
MN1_2	14										
IT1_1	15										
IT1_2	16										
CSO	17			1	1						
EMO	18										
ETCS	19			1							
ET1	20										
ET2_1	21										
ET2_2	22										
FCC	23										
FC1	24										
FC2	25										
GMC	26										
GM1	27										
CHENG	28			1	1						
MPA	29										
GSM2	30										
EM1	31										
ENCS	32			1							
ENC_1	33										
ENC_2	34										
EN1	35										
DCC	36										
GSE1	37										
SKC	38			1	1						
CS1	39										
CS2_1	40										
CS2_2	41										
LOGKEEPER	42										
AFTSTRNG_OP	43										
BNDRY_DESMKING	44										
ACC_OVRHLMN	45										
HAZMAT_TM	46										
ATO	47										
HOOKUP_MAN	48										
OOD	49	1	1								
JOD	50	1	1								
RCO	51	1	1								
EPT	52	1	1								
TAO	53	1	1								
FNS	54	1	1								
DSO	55	1	1								
TSC	56	1	1								
COM	57	1	1								

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APPENDIX G. LCS RESOURCES DATA

BSC	MS #	BILLET TITLE	Rate	PNEC	SNEC
0001	1	CO AFLOAT CDR	1110H		
0002	2	XO AFLOAT	1110I		
0003	3	HOSPITAL CORPSMAN	HM1	8425	
0004	4	COMMAND MASTER CHIEF	CMDMC	9517	0201
0005	5	OPERATIONS OFFICER	1110J		
0006	6	ASSIST OPERATIONS OFFICER	1110K		
0007	7	QUARTERMASTER	QMC	0201	0348
0008	8	OPERATIONS SPECIALIST	OSC_1	0342	0201
0009	9	OPERATIONS SPECIALIST	OSC_2	0324	0201
0010	10	OPERATIONS SPECIALIST	OS1	0327	0348
0011	11	BOATSWAINS MATE	BMC	9595	0201
0012	12	MINEKEEPER	MN1_1	0170	0201
0013	13	MINEKEEPER	MN1_2	0170	0201
0014	14	INFORMATION SYSTEMS TECHNICIAN	IT1_1	2379	1318
0015	15	INFORMATION SYSTEMS TECHNICIAN	IT1_2	1318	2379
0016	16	COMBAT SYSTEMS OFFICER	1110I		
0017	17	ELECTRONICS MATERIAL OFFICER	1605		
0018	18	ELECTRONICS TECHNICIAN	ETCS		
0019	19	ELECTRONICS TECHNICIAN	ET1	1678	1430
0020	20	ELECTRONICS TECHNICIAN	ET2_1	1571	1471
0021	21	ELECTRONICS TECHNICIAN	ET2_2	4758	9604
0022	22	FIRE CONTROLMAN	FCC	1321	1145
0023	23	FIRE CONTROLMAN	FC1	1145	
0024	24	FIRE CONTROLMAN	FC2	1145	
0025	25	GUNNER'S MATE	GMC	0812	4671
0026	26	GUNNER'S MATE	GM1	4671	0812
0027	27	CHIEF ENGINEER	6130		
0028	28	MAIN PROPULSION ASSIST	1110J		
0029	29	GAS TURB SYS TECH MECH	GSM2	4126	9595
0030	30	ELECTRICIAN'S MATE	EM1	4206	4632
0031	31	ENGINEMAN	ENCS	4206	4333
0032	32	ENGINEMAN	ENC_1	4303	4206
0033	33	ENGINEMAN	ENC_2	4303	9595
0034	34	ENGINEMAN	EN1	4303	4291
0035	35	DAMAGE CONTROLMAN	DCC	4206	4811
0036	36	GAS TURB SYS TECH ELEC	GSE1	4125	4124
0037	37	STOREKEEPER	SKC	9595	2828
0038	38	CULINARY SPECIALIST	CS1	3529	3527
0039	39	CULINARY SPECIALIST	CS2_1	3527	3529
0040	40	CULINARY SPECIALIST	CS2_2	3527	

Dept/Div	Baseling Inport Watch Position	Baseline Watch Position (condition 3)
	Watch	Watch
Exec		
Exec		
Exec		
Exec		JOD
OPS	CDO	TAO
OPS	RCOi	OOD
OPS	OODi	JOD
OPS	OODi	TAC
OPS		TAC
OPS	POW	TAC
OPS	OODi	JOD
OPS	POW	
OPS		
OPS	POW	TSC
OPS	OODi	TSC
COMBAT	CDO	TAO
COMBAT	OODi	OOD
COMBAT	OODi	DSO
COMBAT	POW	TSC
COMBAT	POW	COM
COMBAT	POW	COM
COMBAT	POW	COM
COMBAT	POW	CSM
COMBAT	POW	CSM
COMBAT	OODi	GFC
COMBAT	EPTi	GFC
ENG	CDO	TAO
ENG	OODi	OOD
ENG	EPTi	EPT
ENG	RCOi	EPT
ENG	RCOi	RCO
ENG	RCOi	EPT
ENG	RCOi	
ENG	EPTi	
ENG	RCOi	RCO
ENG	EPTi	RCO
SUPPLY	OODi	
SUPPLY		
SUPPLY		
SUPPLY		

GQ	Mtg	SmallArmsQual	PFA	MedDen
GQ	Mtg	SmallArmsQual	PFA	MedDen
GQ	Mtg	SmallArmsQual	PFA	MedDen
CO	CO	1	1	1
XO	XO	1	1	1
		1	1	1
JOD	CMDMC	1	1	1
	OPS	1	1	1
OOD		1	1	1
DC		1	1	1
FNS	OSC_1	1	1	1
ACT		1	1	1
LKO		1	1	1
RLO		1	1	1
LKO		1	1	1
CSW		1	1	1
TSC		1	1	1
FIFTY7M		1	1	1
TAO	CSO	1	1	1
		1	1	1
DSO	ETCS	1	1	1
CSW		1	1	1
CSW		1	1	1
		1	1	1
COM		1	1	1
CSW		1	1	1
DC		1	1	1
GFC		1	1	1
GFC		1	1	1
	CHENG	1	1	1
DC		1	1	1
DC		1	1	1
DC		1	1	1
	ENCS	1	1	1
EPT		1	1	1
DC		1	1	1
DC		1	1	1
DC		1	1	1
RCO		1	1	1
CSW	SKC	1	1	1
CSW		1	1	1
CSW		1	1	1
CSW		1	1	1

Brief				
FRTPBrief	DeptBrief	NavBrief	AnchBrief	COBrief
FRTPBrief	DeptBrief	NavBrief	AnchBrief	COBrief
CO		CO	CO	1
XO	XO	XO	XO	1
HM1				1
CMDMC		CMDMC	CMDMC	1
OPS	OPS	OPS	OPS	1
AOPS		AOPS	AOPS	1
QMC		QMC	QMC	1
OSC_1		OSC_1	OSC_1	1
OSC_2				1
				1
BMC		BMC	BMC	1
				1
				1
				1
				1
CSO	CSO	CSO	CSO	1
EMO		EMO	EMO	1
ETCS		ETCS	ETCS	1
				1
				1
				1
FCC		FCC	FCC	1
				1
				1
GMC		GMC	GMC	1
				1
CHENG	CHENG	CHENG	CHENG	1
MPA		MPA	MPA	1
				1
				1
ENCS		ENCS	ENCS	1
ENC_1				1
ENC_2				1
				1
DCC				1
				1
SKC	SKC	SKC	SKC	1
	SKC	SKC	SKC	1
				1
				1

DutySecDrill		
DutySectOne	DutySectTwo	DutySectThree
DutySectOne	DutySectTwo	DutySectThree
DCi		
	CDO	
RLOi		
		CSWi
CSWi		
	CSWi	
		DCi
	RLOi	
CSWi		
		CSWi
DCi		
		CSWi
		CDO
	CSWi	
CSWi		
	CSWi	
	CSWi	
		CSWi
CSWi		
	DCi	
		CSWi
	CSWi	
CSWi		
CDO		
		RLOi
	DCi	
		DCi
	DCi	
DCi		
		DCi
	DCi	
		DCi
DCi		
DCi		
DCi		
	DCi	
		DCi

Detail			Inspection		
NavDetail	SeaAnchorDetail	AnchDetail	CSInsp	OPSPInsp	ENGSPInsp
NavDetail	SeaAnchorDetail	AnchDetail	CSInsp	OPSPInsp	ENGSPInsp
	CO		CO		
XO	XO				XO
				HM1	
				CMDMC	
		OPS		OPS	
		SAF		AOPS	
NAV				QMC	
OSC_1				OSC_1	
OSC_2				OSC_2	
				OS1	
		BMC		BMC	
LOGKEEPER		LHR		MN1_1	
	CSW	LHR		MN1_2	
				IT1_1	
				IT1_2	
			CSO		
			EMO		
			ETCS		
			ET1		
	CSW	LHR	ET2_1		
	CSW	LHR	ET2_2		
			FCC		
			FC1		
		LHR	FC2		
	FIFTY7M		GMC		
	CSW		GM1		
					CHENG
					MPA
					GSM2
		CAP			EM1
					ENCS
					ENC_1
		SPO			ENC_2
	AFTSTRNG_OP	LHR			EN1
					DCC
		CCO			GSE1
					SKC
					CS1
LKO					CS2_1
LKO					CS2_2

AVCert			
AVCert	AVCert	AVCert	AVCert
FlightQuarters	Vertrep	LaunchRecoverAircraft	SecureFlightQuarters
SAF	SAF		SAF
	HOOKUP_MAN		
CST	CST	CST	CST
LSE	LSE	LSE	LSE
LSE	LSE	LSE	LSE
CST	CST	CST	CST
CST	CST	CST	CST
CST	CST	CST	CST
CST	CST	CST	CST
HCO	HCO	HCO	HCO
SAF	SAF		SAF
WOR	WOR		WOR
WOR	WOR		WOR
CCO	CCO	CCO	CCO
CST	CST	CST	
CCO	CCO	CCO	CCO

AVCert			
AVCert	AVCert	AVCert	AVCert
RefuelAircraft	AirborneHeloEmer	HeloFireOnDeck	AcftFireHangarDeck
		DC	DC
	CST	CST	CST
		LSE	
		LSE	
		CST	CST
	CST	CST	CST
	CST	CST	CST
		DC	DC
	CST	CST	CST
	CST	CST	CST
		HCO	
GSM2			
EM1		DC	DC
			SAF
	DC	DC	DC
	DC	CCO	
	CST	CST	CST
	DC	DC	DC
	DC	CCO	
	DC	DC	DC

ATFPCert		
ATFPCert	ATFPCert	ATFPCert
PlanATFPMission	CnterTerrAct	TransitionFPConditions
CO		
	JOD	
	OOD	
	JOD	
	GUN	GUN
	GUN	GUN
	GUN	GUN
ATO	ATO	ATO
	GUN	GUN
	GUN	GUN
	GUN	GUN
	GUN	GUN
	OOD	OOD
	GUN	GUN
	GUN	GUN
	GUN	GUN
	GUN	GUN
	GUN	GUN
	GUN	GUN

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FSOMCert				
FSOMCert	FSOMCert	FSOMCert	FSOMCert	FSOMCert
PlanMedSupport	DirectManageMed	BDrsngStaOps	NonGQMassCasExer	MajConflagMassCas
HM1	HM1	HM1	HM1	HM1
			RLOi	
			RLOi	
		DC	DC	DC
		DC	DC	DC
		DC	DC	DC
		DC	DC	DC
			DCC	
		DC	DC	DC
		DC	DC	DC

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MOBDCert				
MOBDCert	MOBDCert	MOBDCert	MOBDCert	MOBDCert
AnalzMOBDSHpSurv	RespAndCorrActForFire	RespCorrActForDamageFlood	Shoring	Plugging
		RLO	RLO	RLO
	DC			
	ACC_OVRHLMN			
	ACC_OVRHLMN			
		DC	DC	DC
		DC	DC	DC
	DC	DC	DC	DC
	DC	DC	DC	DC
	DC	DC	DC	DC
	DC	DC	DC	DC
	DC	DC	DC	DC
CHENG				
	DC	DC	DC	DC
	DC	DC	DC	DC
	DC	DC	DC	DC
DCC	DCC			
	DC	DC	DC	DC
		DC	DC	DC
	BNDRY_DESMKING	BNDRY_DESMKING		
	BNDRY_DESMKING	BNDRY_DESMKING		

MOBDCert				
MOBDCert	MOBDCert	MOBDCert	MOBDCert	MOBDCert
PipePatching	RespCorrActForHazMatCas	AssistVesselInDstresUW	RespAndCorrActForCasPwer	ChemWrfareDefProc
RLO				
DC				DC
DC				DC
DC		DC		DC
DC		DC		DC
DC		DC		DC
DC		DC		DC
DC		DC		DC
DC		DC		DC
DC		DC	EM1	DC
DC				DC
	DCC		DCC	
DC			GSE1	DC
DC				DC
	HAZMAT_TM			
	HAZMAT_TM			

MOBDCert				
MOBDCert	MOBDCert	MOBDCert	MOBDCert	MOBDCert
MajConflag	CLASSBMAINMACHFIRE	CrtlHeloFireCrashOnDeck	FightAcftFireOnHgrDk	AcrtFuelingStaFireOnFltDk
CO				
XO	XO			
HM1	HM1			
RLO	RLO			
	BNDRY_DESMKING			
	BNDRY_DESMKING			
DC	DC	CST	CST	CST
DC	DC	CST	CST	CST
DC	DC	CST	CST	CST
DC	DC	CST	CST	CST
DC	DC	CST	CST	CST
DC	DC	CST	CST	CST
DC	DC	DC	DC	DC
DC	DC	DC	DC	DC
DC	DC			
DC	DC	DC	DC	DC
DC	DC	DC	DC	DC
DC	DC	DC	DC	DC
	ACC_OVRHLMN	CST	CST	CST
	ACC_OVRHLMN	CST	CST	CST

MOBDCert			
MOBDCert	MOBDCert	MOBDCert	MOBDCert
AcftFuelStaFireOnHangrDk	AvFuelsSysCaslty	CrtlCSCasulty	CorrActFireFldingCondIIDC
			RLO
CST	CST	IT1_1	
CST	CST	IT1_2	DC
		ETCS	
		ET1	
CST	CST	ET2_1	
CST	CST	ET2_2	
CST	CST		
CST	CST		
DC	DC		DC
			CHENG
DC	DC		DC
		EM1	
DC	DC		DC
			DCC
DC	DC	GSE1	DC
DC	DC		DC
CST	CST		DC
CST	CST		DC

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MOBSCert			
MOBSCert	MOBSCert	MOBSCert	MOBSCert
PlanSeamanshipEvolvs	DirectManageSeaman	GetUW	MooringAlongsidePierShip
		LHR	LHR
OPS	OPS		
AOPS	AOPS	SAF	SAF
	BMC		BMC
	MN1_1	LHR	MN1_1
	MN1_2	LHR	LHR
	IT1_1		
	IT1_2		
		SAF	SAF
		LHR	LHR
		LHR	LHR
		LHR	LHR
		LHR	LHR
		LHR	LHR
		LHR	LHR

MOBSCert			
MOBSCert	MOBSCert	MOBSCert	MOBSCert
MoorShipToBuoy	AnchorShip	AnchorShipAtNight	UNREP
SAF	SAF	SAF	SAF
BMC	BMC	BMC	BMC
MN1_1	MN1_1	MN1_1	MN1_1
	MN1_2	MN1_2	MN1_2
	LHR	LHR	LHR
	LHR	LHR	LHR
	LHR	LHR	LHR
BCX			
BEN	SAF	SAF	SAF
BDO	ENCS	ENCS	ENCS
BDC	ENC_1	ENC_1	ENC_1
	ENC_2	ENC_2	ENC_2
BCX	EN1	EN1	EN1
BDC			
BDO			
	LHR	LHR	LHR
	LHR	LHR	LHR
	LHR	LHR	LHR
	LHR	LHR	LHR

MOBSCert			
MOBSCert	MOBSCert	MOBSCert	MOBSCert
UNREPAtnight	UNREPSingleProbe	ReceiveCargoSTREAM	EmerBreakaway
BMC	BMC	BMC	BMC
MN1_1	MN1_1	MN1_1	MN1_1
MN1_2	MN1_2	MN1_2	MN1_2
LHR	LHR	LHR	LHR
LHR	LHR	LHR	LHR
LHR	LHR	LHR	LHR
SAF	SAF	SAF	SAF
ENCS	ENCS	ENCS	ENCS
ENC_1	ENC_1	ENC_1	ENC_1
ENC_2	ENC_2	ENC_2	ENC_2
EN1	EN1	EN1	EN1
LHR	LHR	LHR	LHR
LHR	LHR	LHR	LHR
LHR	LHR	LHR	LHR
LHR	LHR	LHR	LHR

MOBSCert				
MOBSCert	MOBSCert	MOBSCert	MOBSCert	MOBSCert
SmallBoatOps	ManOvbdShipBoatRescue	ManOvbdShipBoatAtNight	ShipInTow	PrepareHvyWtherAtSea
	HM1	HM1		HM1
				CMDMC
				OPS
SAF	SAF	SAF		
				QMC
	BMC	BMC	BMC	
	MN1_1	MN1_1	MN1_1	
SAF	MN1_2	MN1_2	MN1_2	
			LHR	
			LHR	
			LHR	
	SAF	SAF		GMC
BCX	BCX	BCX		GM1
				CHENG
				MPA
BEN	BEN	BEN	SAF	
BDO	BDO	BDO	ENCS	
BDC	BDC	BDC	ENC_1	
			ENC_2	
BCX	BCX	BCX	EN1	
BDC	BDC	BDC		DCC
BDO	BDO	BDO		
			LHR	SKC
			LHR	
			LHR	
			LHR	

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VBSSCert					
VBSSCert	VBSSCert	VBSSCert	VBSSCert	VBSSCert	VBSSCert
PlanMIOTask	DirectManageVBSS	AdvPrepPhaseI	HlingSusVesToHeavePhaseII	BOSrchPrtyPrepPhaseIII	BoardingPhaseIV
CO					
VBO	VBO	VBO		VBO	VBO
	VBS	VBS		VBS	VBS
	VBS	VBS		VBS	VBS
	VBS	VBS		VBS	VBS
	VBS	VBS		VBS	VBS
	VBS	VBS		VBS	VBS
	VBS	VBS		VBS	VBS
VBO			VBO		
				GSM2	
	VBS	VBS		VBS	VBS
	VBS	VBS		VBS	VBS
				ENC_2	
				EN1	

APPENDIX H. LCS FRTP SCENARIO SHEET

Name	Desc	Desc	Desc	Day In Run	Hrs into Day
	EvoTask	EvoType	EvoStart		
Model Starting Mode	Condition_V	Condition_V	0	1	0.00
Crew Quarters	Qtrts	Qtrts	25200	1	7.00
GMT	Trng	Trng	28800	1	8.00
DeptBrief(s)	DeptBrief	Brief	32400	1	9.00
Small Arms Requal	SmallArmsQual	SmallArmsQual	32400	1	9.00
Daily/Liberty Meeting	Mtg	Mtg	57600	1	16.00
Duty Section Drills	DutySectOne	DutySecDrill	59400	1	16.50
Crew Quarters	Qtrts	Qtrts	111600	2	7.00
GMT	Trng	Trng	115200	2	8.00
DeptBrief(s)	DeptBrief	Brief	118800	2	9.00
Daily/Liberty Meeting	Mtg	Mtg	144000	2	16.00
Duty Section Drills	DutySectTwo	DutySecDrill	145800	2	16.50
Crew Quarters	Qtrts	Qtrts	198000	3	7.00
PFA	PFA	PFA	205200	3	9.00
DeptBrief(s)	DeptBrief	Brief	219600	3	13.00
Daily/Liberty Meeting	Mtg	Mtg	230400	3	16.00
Duty Section Drills	DutySectThree	DutySecDrill	232200	3	16.50
Crew Quarters	Qtrts	Qtrts	284400	4	7.00
Med/Dental	MedDen	MedDen	288000	4	8.00
DeptBrief(s)	DeptBrief	Brief	291600	4	9.00
Daily/Liberty Meeting	Mtg	Mtg	316800	4	16.00
Duty Section Drills	DutySectOne	DutySecDrill	318600	4	16.50

Crew Quarters	Qtrs	Qtrs	370800	5	7.00
GMT	Trng	Trng	374400	5	8.00
DeptBrief(s)	DeptBrief	Brief	378000	5	9.00
Daily/Liberty Meeting	Mtg	Mtg	403200	5	16.00
Duty Section Drills	DutySectTwo	DutySecDrill	405000	5	16.50
Crew Quarters	Qtrs	Qtrs	457200	6	7.00
DeptBrief(s)	DeptBrief	Brief	464400	6	9.00
FRTF Brief(s)	FRTFBrief	Brief	478800	6	13.00
CO/XO Brief	COBrief	Brief	487800	6	15.50
Daily/Liberty Meeting	Mtg	Mtg	490500	6	16.25
Duty Section Drills	DutySectThree	DutySecDrill	491400	6	16.50
Crew Quarters	Qtrs	Qtrs	543600	7	7.00
Crew Training	Trng	Trng	547200	7	8.00
DeptBrief(s)	DeptBrief	Brief	550800	7	9.00
Daily/Liberty Meeting	Mtg	Mtg	576000	7	16.00
Duty Section Drills	DutySectOne	DutySecDrill	577800	7	16.50
Crew Quarters	Qtrs	Qtrs	630000	8	7.00
Nav Brief	NavBrief	Brief	633600	8	8.00
Nav and S&A Detail	NavDetail	Detail	635400	8	8.50
Condition III	Condition_III	Condition_III	637200	8	9.00
Aviation Certification	FlightQuarters	AVCert	639000	8	9.50
	Vertrep	AVCert	644400	8	11.00
	LaunchRecoverAircraft	AVCert	650700	8	12.75
	SecureFlightQuarters	AVCert	651600	8	13.00
	RefuelAircraft	AVCert	655200	8	14.00
	AirborneHeloEmer	AVCert	658800	8	15.00
	HeloFireOnDeck	AVCert	662400	8	16.00
	AcftFireHangarDeck	AVCert	666000	8	17.00
Nav and S&A Detail	NavDetail	Detail	671400	8	18.50
Condition V	Condition_V	Condition_V	673200	8	19.00
Aviation Outbrief	Mtg	Mtg	679500	8	20.75

Crew Quarters	Qtrts	Qtrts	716400	9	7.00
Nav Brief	NavBrief	Brief	720000	9	8.00
ATFP Certification	PlanATFPMission	ATFPCert	721800	9	8.50
	CnterTerrAct	ATFPCert	724500	9	9.25
Nav and S&A Detail	NavDetail	Detail	737100	9	12.75
Condition III	Condition_III	Condition_III	739800	9	13.50
	CnterTerrAct	ATFPCert	740700	9	13.75
Nav and S&A Detail	NavDetail	Detail	759600	9	19.00
Condition V	Condition_V	Condition_V	762300	9	19.75
	TransitionFPConditions	ATFPCert	763200	9	20.00
ATFP Outbrief	Mtg	Mtg	768600	9	21.50
Crew Quarters	Qtrts	Qtrts	802800	10	7.00
Nav Brief(s)	NavBrief	Brief	806400	10	8.00
Nav and S&A Detail	NavDetail	Detail	810000	10	9.00
Condition III	Condition_III	Condition_III	811800	10	9.50
Air Certification	PlanAWMission	AIRCert	811800	10	9.50
	DirectManageAW	AIRCert	813600	10	10.00
	InitializeAWsystems	AIRCert	818100	10	11.25
	DetectAirCnts	AIRCert	820800	10	12.00
	ClassifyAirCnts	AIRCert	824400	10	13.00
	TrackAirCnts	AIRCert	828000	10	14.00
	ReportAirCnts	AIRCert	830700	10	14.75
	EngCntswthArPntDfWpn	AIRCert	831600	10	15.00
	CtrlCSCasualty	AIRCert	835200	10	16.00
	BDA	AIRCert	838800	10	17.00
	CtrlActInAWRole	AIRCert	841500	10	17.75
	EstAndMainLink11	AIRCert	846000	10	19.00
	EstAndMainLink16	AIRCert	847800	10	19.50
	EstAndMainMultiTadilLinks	AIRCert	848700	10	19.75
Nav and S&A Detail	NavDetail	Detail	850500	10	20.25
Condition V	Condition_V	Condition_V	853200	10	21.00
Air Outbrief	Mtg	Mtg	854100	10	21.25

Crew Quarters	Qtrts	Qtrts	889200	11	7.00
CCC Certification	DevCCCCCommsPlan	CCCCCert	894600	11	8.50
	DirectManageCCC	CCCCCert	896400	11	9.00
	HFCCommsSys	CCCCCert	898200	11	9.50
	UHFLOSVHFCommsSys	CCCCCert	900000	11	10.00
	UHFSATComms	CCCCCert	901800	11	10.50
	EHFNECCCommsSys	CCCCCert	903600	11	11.00
	SHFCommsSys	CCCCCert	905400	11	11.50
	DemolInfoExch	CCCCCert	907200	11	12.00
	IT21Archit	CCCCCert	909000	11	12.50
	InfoCtrl	CCCCCert	910800	11	13.00
	ProcDiss	CCCCCert	912600	11	13.50
	InfoSysCasCtrl	CCCCCert	914400	11	14.00
CCC Outbrief/Liberty Mtg	Mtg	Mtg	921600	11	16.00
Crew Quarters	Qtrts	Qtrts	975600	12	7.00
EW Certification	DirectManageEW	EWCert	979200	12	8.00
Condition III	Condition_III	Condition_III	981000	12	8.50
	InitializeEWsystems	EWCert	981000	12	8.50
	ReportESCnts	EWCert	984600	12	9.50
	ConductEMCONOps	EWCert	988200	12	10.50
	DetectESCnts	EWCert	991800	12	11.50
	ClassifyESCnts	EWCert	995400	12	12.50
	TrackESCnts	EWCert	999000	12	13.50
	ConductEAOps	EWCert	1002600	12	14.50
EW Outbrief/Liberty Mtg	Mtg	Mtg	1008900	12	16.25
Duty Section Drills	DutySectThree	DutySecDrill	1013400	12	17.50

Crew Quarters	Qtrrs	Qtrrs		13
FSO-M Certification	PlanMedSupport	FSOMCert	1069200	13
	DirectManageMed	FSOMCert	1071000	13
	BDrsngStaOps	FSOMCert	1074600	13
Condition_III	Condition_III	Condition_III	1076400	13
	NonGQMassCasExer	FSOMCert	1080000	13
	MajConflagMassCas	FSOMCert	1085400	13
	MajConflag	MOBDCert	1089000	13
Condition_I	Condition_I	Condition_I	1092600	13
AbandonShip	AbandonShip	AbandonShip	1098900	13
Condition_V	Condition_V	Condition_V	1101600	13
FSO-M Outbrief	Mtg	Mtg	1106100	13
Crew Quarters	Qtrrs	Qtrrs	1148400	14
INT Certification	CndtFsonINTAnal	INTCert	1153800	14
	CndtIntColl	INTCert	1157400	14
	OpIntelSuppToCDR	INTCert	1161000	14
	RptIntellInfo	INTCert	1162800	14
	ThreatAssesToWtchStdrs	INTCert	1165500	14
CO/XO Walkthru	Walkthru	Walkthru	1179000	14
INT Outbrief	Mtg	Mtg	1181700	14
Duty Section Drills	DutySectTwo	DutySecDrill	1183500	14

Crew Quarters	Qtrts	Qtrts	1234800	15
Nav Brief(s)	NavBrief	Brief	1238400	15
Nav and S&A Detail	NavDetail	Detail	1240200	15
Condition III	Condition_III	Condition_III	1242900	15
MOB-D Certification	AnalzMOBDSHpSurv	MOBDCert	1243800	15
	RespAndCorrActForFire	MOBDCert	1243800	15
	RespCorrActForDamageFlood	MOBDCert	1244700	15
	Shoring	MOBDCert	1247400	15
	Plugging	MOBDCert	1250100	15
	PipePatching	MOBDCert	1252800	15
	RespCorrActForHazMatCas	MOBDCert	1255500	15
	AssistVesselInDstresUW	MOBDCert	1258200	15
	RespAndCorrActForCasPwer	MOBDCert	1260900	15
	ChemWrfareDefProc	MOBDCert	1263600	15
	CLASSBMAINMACHFIRE	MOBDCert	1266300	15
	CrtlHeloFireCrashOnDeck	MOBDCert	1269000	15
	FightAcftFireOnHgrDk	MOBDCert	1270800	15
	AcrtFuelingStaFireOnFltDk	MOBDCert	1272600	15
	AcftFuelStaFireOnHangrDk	MOBDCert	1274400	15
	AvFuelsSysCaslty	MOBDCert	1276200	15
	CrtlCSCasulty	MOBDCert	1278000	15
	CorrActFireFlidingCondIIDC	MOBDCert	1279800	15
NavDetail and S&A Detail	NavDetail	Detail	1282500	15
Condition V	Condition_V	Condition_V	1287000	15
MOB-D Outbrief	Mtg	Mtg	1287900	15
Crew Quarters	Qtrts	Qtrts	1321200	16
MOB-E(DSL)Certification	PlanSfeDSLEngOps	DSLCert	1324800	16
	DirectManEngOps	DSLCert	1328400	16
	OpDSLEngPlant	DSLCert	1332000	16
	ExecDSLEvolutions	DSLCert	1335600	16
	DSLEngineRmEvolutions	DSLCert	1339200	16
	ElecEvolutions	DSLCert	1342800	16
	AuxEquipEvolutions	DSLCert	1346400	16
	IntegratedDrills	DSLCert	1350000	16
MOB-E(DSL) Outbrief	Mtg	Mtg	1353600	16

Crew Quarters	Qtrts	Qtrts	1407600	17
MOB-E(GS) Certification	PlanSfeGSEEngOps	GSCert	1411200	17
	DirectManageGS	GSCert	1414800	17
	OpGSEngPlant	GSCert	1416600	17
	ExecGSEvol	GSCert	1420200	17
	CCSPropEvol	GSCert	1423800	17
	CCSElectEvol	GSCert	1427400	17
	GSEngRmEvol	GSCert	1431000	17
	GSAuxEquipEvol	GSCert	1434600	17
	OilLabEvol	GSCert	1438200	17
	SWBEvol	GSCert	1441800	17
	GSIntegratedDrills	GSCert	1445400	17
MOB-E(GS) Outbrief	Mtg	Mtg	1456200	17
Crew Quarters	Qtrts	Qtrts	1494000	18
Nav Brief(s)	NavBrief	Brief	1497600	18
NavDetail and S&A Detail	NavDetail	Detail	1499400	18
Condition III	Condition_III	Condition_III	1502100	18
MOB-S Certification	GetUW	MOBSCert	1503000	18
	PlanSeamanshipEvol	MOBSCert	1505700	18
	DirectManageSeaman	MOBSCert	1507500	18
	PrepareHvyWtherAtSea	MOBSCert	1508400	18
	MoorShipToBuoy	MOBSCert	1509300	18
	AnchorShip	MOBSCert	1512000	18
	SmallBoatOps	MOBSCert	1514700	18
	ShipInTow	MOBSCert	1517400	18
	ManOvbdShipBoatRescue	MOBSCert	1521000	18
	UNREP	MOBSCert	1523700	18
	ReceiveCargoSTREAM	MOBSCert	1527300	18
	UNREPAtnight	MOBSCert	1529100	18
	EmerBreakaway	MOBSCert	1531800	18
	ManOvbdShipBoatAtNight	MOBSCert	1535400	18
	AnchorShipAtNight	MOBSCert	1540800	18
NavDetail and S&A Detail	NavDetail	Detail	1543500	18
	MooringAlongsidePierShip	MOBSCert	1545300	18
Condition V	Condition_V	Condition_V	1547100	18
MOB-S Outbrief	Mtg	Mtg	1548000	18

Crew Quarters	Qtrrs	Qtrrs	1580400	19
Nav Brief(s)	NavBrief	Brief	1584000	19
NavDetail and S&A Detail	NavDetail	Detail	1585800	19
Condition III	Condition_III	Condition_III	1588500	19
MOB-N Certification	NavigateShip	MOBNCert	1588500	19
	PilotByGyro	MOBNCert	1591200	19
	PilotLossOfGyro	MOBNCert	1594800	19
	PilotLowVis	MOBNCert	1596600	19
	PilotSweptChannel	MOBNCert	1598400	19
Anchoring Detail	PrecisionAnchoring	Detail	1600200	19
	MaintainNavLogs	MOBNCert	1602000	19
	OpenOceanTransit	MOBNCert	1602900	19
	LossSteeringRM	MOBNCert	1604700	19
	SurfWthrObs	MOBNCert	1606500	19
	NavigateUsingECDISN	MOBNCert	1608300	19
	PilotByGyroNight	MOBNCert	1616400	19
	PilotLossOfGyroNight	MOBNCert	1618200	19
	PilotLowVisibilityNight	MOBNCert	1620000	19
	PilotSweptChannelNight	MOBNCert	1621800	19
NavDetail and S&A Detail	NavDetail	Detail	1623600	19
Condition V	Condition_V	Condition_V	1626300	19
MOB-N Outbrief	Mtg	Mtg	1627200	19

Crew Quarters	Qtrrs	Qtrrs	1666800	20
Nav Brief(s)	NavBrief	Brief	1670400	20
NavDetail and S&A Detail	NavDetail	Detail	1672200	20
Condition III	Condition_III	Condition_III	1674900	20
SW Certification	PlanSWMission	SWCert	1674900	20
	DirectManageSW	SWCert	1675800	20
	InitializeSWsystems	SWCert	1677600	20
	DetectSWCnts	SWCert	1680300	20
	ClassifySWCnts	SWCert	1683900	20
	TrackSWCnts	SWCert	1687500	20
	ReportSWCnts	SWCert	1691100	20
	EngageSWCnts	SWCert	1694700	20
	CdtTactCombatAssess	SWCert	1698300	20
	CrtlAcftSWSynthetic	SWCert	1701900	20
	CndtOpComms	SWCert	1705500	20
	CdtGCCSMDatabaseMgmt	SWCert	1709100	20
NavDetail and S&A Detail	NavDetail	Detail	1712700	20
Condition V	Condition_V	Condition_V	1715400	20
SW Outbrief	Mtg	Mtg	1716300	20

Crew Quarters	Qtrrs	Qtrrs	1753200	21
Nav Brief(s)	NavBrief	Brief	1756800	21
NavDetail and S&A Detail	NavDetail	Detail	1758600	21
Condition III	Condition_III	Condition_III	1761300	21
VBSS Certification	PlanMIOTask	VBSSCert	1761300	21
	DirectManageVBSS	VBSSCert	1763100	21
	AdvPrepPhaseI	VBSSCert	1764900	21
	HlingSusVesToHeavePhaseII	VBSSCert	1768500	21
	BOSrchPrtyPrepPhaseIII	VBSSCert	1770300	21
	BoardingPhaseIV	VBSSCert	1771200	21
	SecurityPhaseV	VBSSCert	1774800	21
	SearchPhaseVI	VBSSCert	1776600	21
	EgressPhaseVII	VBSSCert	1778400	21
	SiezVesselPhaseVIII	VBSSCert	1780200	21
	PostBrdingPhaseIX	VBSSCert	1782000	21
SAR Certification	CndtSrchAndResMiss	SARCert	1785600	21
NavDetail and S&A Detail	NavDetail	Detail	1792800	21
Condition V	Condition_V	Condition_V	1795500	21
CO/XO FRTP Outbrief	FRTPBrief	Brief	1796400	21
CO Brief to crew	COBrief	Brief	1800000	21
	End	End	1814400	22

APPENDIX I. LCS TRUMP DATA

Item	AbandonShip	GQ																																								
		AVCert	ATFCert	AIRCert	CCCCert	EWCCert	FSOMCert	INTCert	MOBDCert	DSLCCert	GSCert	MOBSCert	MOBNCert	SWCCert	VBSSCert	SARCert	Detail	WatchTurn	Qtrs	Eat	DutySecDrill	Trng	Brief	Mtg	SmallArmsQual	MedDen	Inspection	Sweepers	NormWork	Maint	PersTime	DutyCook	NormalSleep	Walkthru	AdWork	RevHyg	DivineSer	OptSleep	Liberty			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42

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APPENDIX J. LCS CONDITION TRUMP DATA

		<u>Item</u>
Condition V	1	1 AbandonShip
Condition III	2	1 GQ
Condition I	3	1 AVCert
		1 ATFP Cert
		1 AIRCert
		1 CCCCert
		1 EWCert
		1 FSOMCert
		1 INTCert
		1 MOBDCert
		1 DSLCert
		1 GSCert
		1 MOBSCert
		1 MOBNCert
		1 SWCert
		1 VBSSCert
		1 SARCert
		1 Detail
		1 WatchTurn
		1 Watch
		1 Qtrs
		1 Eat
		1 DutySecDrill
		1 Trng
		1 Brief
		1 Mtg
		1 SmallArmsQual
		1 PFA
		1 MedDen
		1 Inspections
		1 Sweepers
		1 NormWork
		1 Maint
		1 PersTime
		1 DutyCook
		1 NormalSleep
		1 Walkthru
		1 AdWork
		1 RevHyg
		1 DivineSer
		1 OptSleep
		1 Liberty

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APPENDIX K. LCS FRTP SUCCESSFUL EVOLUTIONS

Days	Hours	Minutes	clock	Evolution #	Evolution Type	Number of Crewmembers Participating
1	0	0	0	112	Qrtrs	37
1	7	0	25200	2	Qrtrs	2
1	8	0	28800	3	Trng	33
1	9	0	32400	4	DeptBrief	5
1	9	0	32400	5	SmallArmsQual	0
1	16	0	57600	6	Mtg	9
1	16	30	59400	7	DutySectOne	11
2	7	0	111600	8	Qrtrs	2
2	8	0	115200	9	Trng	33
2	9	0	118800	10	DeptBrief	5
2	16	0	144000	11	Mtg	8
2	16	30	145800	12	DutySectTwo	9
3	7	0	198000	13	Qrtrs	2
3	9	0	205200	14	PFA	27
3	13	0	219600	15	DeptBrief	5
3	16	0	230400	16	Mtg	10
3	16	30	232200	17	DutySectThree	9
4	7	0	284400	18	Qrtrs	2
4	8	0	288000	19	MedDen	33
4	9	0	291600	20	DeptBrief	5
4	16	0	316800	21	Mtg	9
4	16	30	318600	22	DutySectOne	11
5	7	0	370800	23	Qrtrs	2
5	8	0	374400	24	Trng	33
5	9	0	378000	25	DeptBrief	5
5	16	0	403200	26	Mtg	8
5	16	30	405000	27	DutySectTwo	9

6	7	0	457200	28	Qrtrs	2
6	9	0	464400	29	DeptBrief	5
6	13	0	478800	30	FRTPBrief	22
6	15	30	487800	31	COBrief	36
6	16	15	490500	32	Mtg	10
6	16	30	491400	33	DutySectThree	9
7	7	0	543600	34	Qrtrs	2
7	8	0	547200	35	Trng	33
7	9	0	550800	36	DeptBrief	5
7	16	0	576000	37	Mtg	9
7	16	30	577800	38	DutySectOne	11
8	7	0	630000	39	Qrtrs	2
8	8	0	633600	40	NavBrief	17
8	8	30	635400	41	NavDetail	7
8	9	30	639000	43	FlightQuarters	11
8	9	30	639000	266	Watch	0
8	9	30	639000	267	Watch	0
8	11	0	644400	44	Vertrep	10
8	11	0	644400	269	Watch	0
8	12	0	648000	268	Watch	0
8	12	45	650700	45	LaunchRecoverAircraft	8
8	12	45	650700	270	Watch	0
8	13	0	651600	46	SecureFlightQuarters	11
8	13	0	651600	271	Watch	0
8	14	0	655200	47	RefuelAircraft	2
8	14	0	655200	272	Watch	0
8	15	0	658800	48	AirborneHeloEmer	9
8	15	0	658800	273	Watch	0

8	16	0	662400	49	HeloFireOnDeck	9
8	16	0	662400	274	Watch	0
8	16	0	662400	275	Watch	0
8	16	0	662400	276	Watch	0
8	17	0	666000	50	AcftFireHangarDeck	9
8	17	0	666000	277	Watch	0
8	17	0	666000	278	Watch	0
8	18	30	671400	51	NavDetail	7
8	18	30	671400	279	Watch	0
8	20	45	679500	53	Mtg	8
9	7	0	716400	54	Qrtrs	2
9	8	30	721800	56	PlanATFPMission	2
9	9	15	724500	57	CnterTerrAct	15
9	9	15	724500	280	Watch	0
9	12	15	735300	281	Watch	0
9	12	45	737100	58	NavDetail	7
9	13	45	740700	60	CnterTerrAct	15
9	13	45	740700	283	Watch	0
9	13	45	740700	284	Watch	0
9	18	0	756000	282	Watch	0
9	18	0	756000	285	Watch	0
9	18	0	756000	286	Watch	0
9	19	0	759600	61	NavDetail	7
9	19	0	759600	287	Watch	0
9	20	0	763200	63	TransitionFPConditions	13
9	21	30	768600	64	Mtg	10
10	7	0	802800	65	Qrtrs	2
10	8	0	806400	66	NavBrief	17
10	9	0	810000	67	NavDetail	7
10	10	0	813600	70	DirectManageAW	1

10	11	15	818100	71	InitializeAWSsystems	2
10	12	0	820800	72	DetectAirCnts	3
10	12	0	820800	288	Watch	0
10	13	0	824400	73	ClassifyAirCnts	2
10	13	0	824400	289	Watch	0
10	14	0	828000	74	TrackAirCnts	2
10	14	0	828000	290	Watch	0
10	14	45	830700	75	ReportAirCnts	2
10	14	45	830700	291	Watch	0
10	15	0	831600	76	EngCntswthArPntDfWpn	2
10	15	0	831600	292	Watch	0
10	16	0	835200	77	CtrlCSCasualty	2
10	16	0	835200	293	Watch	0
10	16	0	835200	294	Watch	0
10	17	0	838800	78	BDA	3
10	17	0	838800	295	Watch	0
10	17	0	838800	296	Watch	0
10	17	45	841500	79	CtrlAcftInAWRole	2
10	17	45	841500	297	Watch	0
10	19	0	846000	80	EstAndMainLink11	1
10	19	0	846000	298	Watch	0
10	19	30	847800	81	EstAndMainLink16	1
10	19	45	848700	82	EstAndMainMultiTadilLinks	1
10	20	15	850500	83	NavDetail	7
10	20	15	850500	299	Watch	0
10	21	15	854100	85	Mtg	9
11	7	0	889200	86	Qrtrs	2
11	8	30	894600	87	DevCCCCCommsPlan	5
11	8	30	894600	300	Watch	0
11	9	0	896400	88	DirectManageCCC	4

11	9	30	898200	89	HFCommsSys	4
11	10	0	900000	90	UHFLOSvhFCommsSys	4
11	10	30	901800	91	UHFSATComms	4
11	11	0	903600	92	EHFNECCCommsSys	4
11	11	30	905400	93	SHFCommsSys	4
11	12	0	907200	94	DemoInfoExch	4
11	12	30	909000	95	IT21Archit	4
11	13	0	910800	96	InfoCtrl	4
11	13	30	912600	97	ProcDiss	4
11	14	0	914400	98	InfoSysCasCtrl	4
11	16	0	921600	99	Mtg	8
12	7	0	975600	100	Qrtrs	2
12	8	0	979200	101	DirectManageEW	1
12	8	30	981000	103	InitializeEWsystems	2
12	9	30	984600	104	ReportESCnts	2
12	10	30	988200	105	ConductEMCONops	1
12	11	30	991800	106	DetectESCnts	1
12	12	30	995400	107	ClassifyESCnts	1
12	13	30	999000	108	TrackESCnts	1
12	14	30	1002600	109	ConductEAops	1
13	9	0	1069200	113	PlanMedSupport	1
13	9	30	1071000	114	DirectManageMed	1
13	10	30	1074600	115	BDrngStaOps	6
13	12	0	1080000	117	NonGQMassCasExer	8
13	12	0	1080000	301	Watch	0
13	12	0	1080000	302	Watch	0
13	12	0	1080000	303	Watch	0
13	12	0	1080000	304	Watch	0
13	13	30	1085400	118	MajConflagMassCas	6
13	13	30	1085400	305	Watch	0

13	13	30	1085400	306	Watch	0
13	13	30	1085400	307	Watch	0
13	14	30	1089000	119	MajConflag	14
13	14	30	1089000	308	Watch	0
13	14	30	1089000	309	Watch	0
13	17	15	1098900	121	AbandonShip	40
13	19	15	1106100	123	Mtg	9
14	7	0	1148400	124	Qrtrs	2
14	8	30	1153800	125	CndtFsionINTAnal	2
14	9	30	1157400	126	CndtIntColl	2
14	10	30	1161000	127	OpIntelSuppToCDR	2
14	11	0	1162800	128	RptIntelInfo	2
14	11	45	1165500	129	ThreatAssesToWtchStdrs	2
14	15	30	1179000	130	Walkthru	0
14	16	15	1181700	131	Mtg	8
14	16	45	1183500	132	DutySectTwo	9
15	7	0	1234800	133	Qrtrs	2
15	8	30	1240200	135	NavDetail	7
15	9	30	1243800	137	AnalzMOBDSHpSurv	2
15	9	30	1243800	310	Watch	0
15	9	45	1244700	139	RespCorrActForDamageFlood	10
15	9	45	1244700	311	Watch	0
15	9	45	1244700	312	Watch	0
15	9	45	1244700	313	Watch	0
15	9	45	1244700	314	Watch	0
15	10	30	1247400	140	Shoring	8
15	10	30	1247400	315	Watch	0
15	10	30	1247400	316	Watch	0

15	10	30	1247400	317	Watch	0
15	11	15	1250100	141	Plugging	8
15	11	15	1250100	318	Watch	0
15	11	15	1250100	319	Watch	0
15	11	15	1250100	320	Watch	0
15	12	0	1252800	142	PipePatching	8
15	12	0	1252800	321	Watch	0
15	12	0	1252800	322	Watch	0
15	12	0	1252800	323	Watch	0
15	12	45	1255500	143	RespCorrActForHazMatCas	3
15	13	30	1258200	144	AssistVesselInDstresUW	3
15	14	15	1260900	145	RespAndCorrActForCasPwer	3
15	14	15	1260900	324	Watch	0
15	15	0	1263600	146	ChemWrfareDefProc	7
15	15	0	1263600	325	Watch	0
15	15	0	1263600	326	Watch	0
15	15	45	1266300	147	CLASSEMAINMACHFIRE	17
15	15	45	1266300	327	Watch	0
15	15	45	1266300	328	Watch	0
15	15	45	1266300	329	Watch	0
15	16	30	1269000	148	CrtlHeloFireCrashOnDeck	7
15	16	30	1269000	330	Watch	0
15	16	30	1269000	331	Watch	0
15	17	0	1270800	149	FightAcftFireOnHgrDk	7
15	17	0	1270800	332	Watch	0
15	17	0	1270800	333	Watch	0
15	17	30	1272600	150	AcrtFuelingStaFireOnFltDk	7
15	17	30	1272600	334	Watch	0
15	18	0	1274400	151	AcftFuelStaFireOnHangrDk	7

15	18	0	1274400	335	Watch	0
15	18	30	1276200	152	AvFuelsSysCaslty	7
15	18	30	1276200	336	Watch	0
15	19	0	1278000	153	CrtlCSCasulty	4
15	19	30	1279800	154	CorrActFireFldingCondI IDC	8
15	20	15	1282500	155	NavDetail	7
15	20	15	1282500	337	Watch	0
15	21	45	1287900	157	Mtg	10
16	7	0	1321200	158	Qrtrs	2
16	8	0	1324800	159	PlanSfeDSLEngOps	2
16	9	0	1328400	160	DirectManEngOps	3
16	10	0	1332000	161	OpDSLEngPlant	8
16	10	0	1332000	338	Watch	0
16	11	0	1335600	162	ExecDSLEvolutions	5
16	12	0	1339200	163	DSLEngineRmEvolutions	5
16	13	0	1342800	164	ElecEvolutions	6
16	13	0	1342800	339	Watch	0
16	14	0	1346400	165	AuxEquipEvolutions	5
16	15	0	1350000	166	IntegratedDrills	8
16	16	0	1353600	167	Mtg	9
17	7	0	1407600	168	Qrtrs	2
17	8	0	1411200	169	PlanSfeGSEEngOps	8
17	9	0	1414800	170	DirectManageGS	8
17	9	30	1416600	171	OpGSEngPlant	8
17	9	30	1416600	340	Watch	0
17	10	30	1420200	172	ExecGSEvol	6
17	11	30	1423800	173	CCSPropEvol	4
17	12	30	1427400	174	CCSElectEvol	6
17	13	30	1431000	175	GSEngRmEvol	0

17	14	30	1434600	176	GSAuxEquipEvolS	4
17	15	0	1436400	341	Watch	0
17	15	30	1438200	177	OilLabEvolS	5
17	15	30	1438200	342	Watch	0
17	16	30	1441800	178	SWBDEvolS	3
17	16	30	1441800	343	Watch	0
17	17	30	1445400	179	GSIntegratedDrills	9
17	18	0	1447200	344	Watch	0
17	20	30	1456200	180	Mtg	8
18	7	0	1494000	181	Qrtrs	2
18	8	30	1499400	183	NavDetail	7
18	9	30	1503000	185	GetUW	7
18	10	15	1505700	186	PlanSeamanshipEvolS	2
18	10	45	1507500	187	DirectManageSeaman	6
18	11	0	1508400	188	PrepareHvyWtherAtSea	9
18	11	0	1508400	345	Watch	0
18	11	0	1508400	346	Watch	0
18	11	0	1508400	347	Watch	0
18	11	15	1509300	189	MoorShipToBuoy	7
18	12	0	1512000	190	AnchorShip	9
18	12	0	1512000	348	Watch	0
18	12	45	1514700	191	SmallBoatOps	5
18	12	45	1514700	349	Watch	0
18	12	45	1514700	350	Watch	0
18	13	30	1517400	192	ShipInTow	10
18	14	30	1521000	193	ManOvbdShipBoatRescue	9
18	14	30	1521000	351	Watch	0
18	14	30	1521000	352	Watch	0
18	14	30	1521000	353	Watch	0

18	15	15	1523700	194	UNREP	8
18	15	15	1523700	354	Watch	0
18	16	15	1527300	195	ReceiveCargoSTREAM	8
18	16	45	1529100	196	UNREPAtnight	8
18	17	30	1531800	197	EmerBreakaway	8
18	18	30	1535400	198	ManOvbdShipBoatAtNight	9
18	18	30	1535400	355	Watch	0
18	18	30	1535400	356	Watch	0
18	18	30	1535400	357	Watch	0
18	20	0	1540800	199	AnchorShipAtNight	9
18	20	0	1540800	358	Watch	0
18	20	0	1540800	359	Watch	0
18	20	45	1543500	200	NavDetail	7
18	20	45	1543500	360	Watch	0
18	21	15	1545300	201	MooringAlongsidePierShip	9
18	21	15	1545300	361	Watch	0
18	22	0	1548000	203	Mtg	10
19	7	0	1580400	204	Qtrrs	2
19	8	0	1584000	205	NavBrief	17
19	8	30	1585800	206	NavDetail	7
19	9	15	1588500	208	NavigateShip	5
19	10	0	1591200	209	PilotByGyro	5
19	11	0	1594800	210	PilotLossOfGyro	4
19	11	30	1596600	211	PilotLowVis	6
19	12	0	1598400	212	PilotSweptChannel	6
19	12	0	1598400	362	Watch	0
19	12	0	1598400	363	Watch	0
19	12	30	1600200	213	PrecisionAnchoring	5
19	12	30	1600200	364	Watch	0
19	13	0	1602000	214	MaintainNavLogs	3

19	13	0	1602000	365	Watch	0
19	13	15	1602900	215	OpenOceanTransit	4
19	13	15	1602900	366	Watch	0
19	13	45	1604700	216	LossSteeringRM	6
19	13	45	1604700	367	Watch	0
19	13	45	1604700	368	Watch	0
19	14	15	1606500	217	SurfWthrObs	1
19	14	15	1606500	369	Watch	0
19	14	45	1608300	218	NavigateUsingECDISN	1
19	14	45	1608300	370	Watch	0
19	17	0	1616400	219	PilotByGyroNight	4
19	17	0	1616400	371	Watch	0
19	17	30	1618200	220	PilotLossOfGyroNight	4
19	17	30	1618200	372	Watch	0
19	18	0	1620000	221	PilotLowVisibilityNight	6
19	18	0	1620000	373	Watch	0
19	18	30	1621800	222	PilotSweptChannelNight	6
19	18	30	1621800	374	Watch	0
19	18	30	1621800	375	Watch	0
19	19	0	1623600	223	NavDetail	7
19	19	0	1623600	376	Watch	0
19	20	0	1627200	225	Mtg	8
20	7	0	1666800	226	Qrtrs	2
20	8	0	1670400	227	NavBrief	17
20	8	30	1672200	228	NavDetail	7
20	9	15	1674900	230	PlanSWMission	4
20	9	15	1674900	377	Watch	0
20	9	15	1674900	378	Watch	0
20	9	30	1675800	231	DirectManageSW	4
20	9	30	1675800	379	Watch	0

20	9	30	1675800	380	Watch	0
20	9	30	1675800	381	Watch	0
20	9	30	1675800	382	Watch	0
20	10	0	1677600	232	InitializeSWsystems	1
20	10	45	1680300	233	DetectSWCnts	1
20	11	45	1683900	234	ClassifySWCnts	3
20	11	45	1683900	383	Watch	0
20	12	45	1687500	235	TrackSWCnts	1
20	12	45	1687500	384	Watch	0
20	13	45	1691100	236	ReportSWCnts	1
20	13	45	1691100	385	Watch	0
20	14	45	1694700	237	EngageSWCnts	2
20	15	45	1698300	238	CdtTactCombatAssess	4
20	15	45	1698300	386	Watch	0
20	16	45	1701900	239	CrtlAcftSWSynthetic	2
20	16	45	1701900	387	Watch	0
20	17	45	1705500	240	CndtOpComms	1
20	18	45	1709100	241	CdtGCCSMDatabaseMgmt	1
20	19	45	1712700	242	NavDetail	7
20	19	45	1712700	388	Watch	0
20	20	45	1716300	244	Mtg	8
21	7	0	1753200	245	Qrtrs	2
21	8	30	1758600	247	NavDetail	7
21	9	15	1761300	249	PlanMIOTask	3
21	9	45	1763100	250	DirectManageVBSS	8
21	9	45	1763100	389	Watch	0
21	9	45	1763100	390	Watch	0
21	10	15	1764900	251	AdvPrepPhaseI	8
21	10	15	1764900	391	Watch	0
21	10	15	1764900	392	Watch	0

21	11	15	1768500	252	HlingSusVesToHeavePhaseII	1
21	11	45	1770300	253	BOsrchPrtyPrepPhaseIII	8
21	11	45	1770300	393	Watch	0
21	11	45	1770300	394	Watch	0
21	12	0	1771200	254	BoardingPhaseIV	8
21	12	0	1771200	395	Watch	0
21	12	0	1771200	396	Watch	0
21	12	0	1771200	397	Watch	0
21	13	0	1774800	255	SecurityPhaseV	8
21	13	0	1774800	398	Watch	0
21	13	0	1774800	399	Watch	0
21	13	0	1774800	400	Watch	0
21	13	30	1776600	256	SearchPhaseVI	8
21	13	30	1776600	401	Watch	0
21	13	30	1776600	402	Watch	0
21	13	30	1776600	403	Watch	0
21	14	0	1778400	257	EgressPhaseVII	7
21	14	0	1778400	404	Watch	0
21	14	0	1778400	405	Watch	0
21	14	30	1780200	258	SiezVesselPhaseVIII	7
21	14	30	1780200	406	Watch	0
21	14	30	1780200	407	Watch	0
21	15	0	1782000	259	PostBrdingPhaseIX	7
21	15	0	1782000	408	Watch	0
21	15	0	1782000	409	Watch	0
21	16	0	1785600	260	CndtSrchAndResMiss	2
21	18	0	1792800	261	NavDetail	7
21	18	0	1792800	410	Watch	0
21	20	0	1800000	264	COBrief	37

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APPENDIX L. LCS FRTP FAILED EVOLUTIONS

Evolution #	Condition	Evolution Type	FailCode	Crewmembers Not Participating
6	Condition_V	OptSleep	Interrupted	0006 - ASSIST OPERATIONS OFFICER
8	Condition_V	OptSleep	Interrupted	0008 - OPERATIONS SPECIALIST
14	Condition_V	OptSleep	Interrupted	0014 - INFORMATION SYSTEMS TECHNICIAN
36	Condition_V	OptSleep	Interrupted	0036 - GAS TURB SYS TECH ELEC
55	Condition_V	NavBrief	Failure	BMC
69	Condition_III	PlanAWMission	Failure	OSC_1
15	Condition_V	OptSleep	Interrupted	0015 - INFORMATION SYSTEMS TECHNICIAN
21	Condition_V	OptSleep	Interrupted	0021 - ELECTRONICS TECHNICIAN
24	Condition_V	OptSleep	Interrupted	0024 - FIRE CONTROLMAN
28	Condition_V	OptSleep	Interrupted	0028 - MAIN PROPULSION ASSIST
30	Condition_V	OptSleep	Interrupted	0030 - ELECTRICIAN'S MATE
33	Condition_V	OptSleep	Interrupted	0033 - ENGINEMAN
110	Condition_III	Mtg	Failure	CMDMC
111	Condition_III	DutySectThree	Cancelled	-
21	Condition_III	OptSleep	Interrupted	0021 - ELECTRONICS TECHNICIAN
134	Condition_V	NavBrief	Failure	BMC
138	Condition_III	RespAndCorrActForFire	Failure	DCC
25	Condition_V	OptSleep	Interrupted	0025 - GUNNER'S MATE
34	Condition_V	OptSleep	Interrupted	0034 - ENGINEMAN
182	Condition_V	NavBrief	Failure	BMC
25	Condition_V	OptSleep	Interrupted	0025 - GUNNER'S MATE
34	Condition_V	OptSleep	Interrupted	0034 - ENGINEMAN
21	Condition_V	OptSleep	Interrupted	0021 - ELECTRONICS TECHNICIAN
28	Condition_V	OptSleep	Interrupted	0028 - MAIN PROPULSION ASSIST
6	Condition_V	OptSleep	Interrupted	0006 - ASSIST OPERATIONS OFFICER
8	Condition_V	OptSleep	Interrupted	0008 - OPERATIONS SPECIALIST
14	Condition_V	OptSleep	Interrupted	0014 - INFORMATION SYSTEMS TECHNICIAN
36	Condition_V	OptSleep	Interrupted	0036 - GAS TURB SYS TECH ELEC
246	Condition_V	NavBrief	Failure	BMC
263	Condition_V	FRTPBrief	Failure	QMC

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APPENDIX M. LCS FRTP FATIGUE LEVELS

Crewmembers	Avg	Max	Sum
CO AFLOAT CDR	1.97	5.64	3968.93
XO AFLOAT	1.97	5.64	3968.93
HOSPITAL CORPSMAN	1.87	4.63	3771.87
COMMAND MASTER CHIEF	2.02	6.23	4069.65
OPERATIONS OFFICER	1.90	5.64	3836.54
ASSIST OPERATIONS OFFICER	4.08	11.19	8228.36
QUARTERMASTER	1.85	5.08	3736.10
OPERATIONS SPECIALIST	4.25	11.19	8571.19
OPERATIONS SPECIALIST	1.84	4.63	3701.36
OPERATIONS SPECIALIST	1.80	5.08	3627.83
BOATSWAINS MATE	3.14	8.49	6333.79
MINEKEEPER	4.10	10.62	8261.11
MINEKEEPER	1.87	4.63	3771.87
INFORMATION SYSTEMS TECHNICIAN	2.60	5.50	5238.13
INFORMATION SYSTEMS TECHNICIAN	2.39	5.82	4811.96
COMBAT SYSTEMS OFFICER	1.85	5.98	3734.64
ELECTRONICS MATERIAL OFFICER	1.81	4.63	3640.37
ELECTRONICS TECHNICIAN	1.97	5.50	3966.13
ELECTRONICS TECHNICIAN	4.91	12.00	9897.90
ELECTRONICS TECHNICIAN	3.18	8.49	6404.72
ELECTRONICS TECHNICIAN	3.00	8.82	6045.09
FIRE CONTROLMAN	1.91	5.50	3844.92
FIRE CONTROLMAN	1.81	4.63	3640.37
FIRE CONTROLMAN	2.29	5.75	4610.72
GUNNER'S MATE	4.78	11.59	9634.79
GUNNER'S MATE	4.12	10.62	8315.01
CHIEF ENGINEER	2.02	6.23	4069.65
MAIN PROPULSION ASSIST	2.65	7.25	5344.36
GAS TURB SYS TECH MECH	3.14	8.49	6333.79
ELECTRICIAN'S MATE	2.29	5.75	4606.89
ENGINEMAN	1.90	5.64	3836.54
ENGINEMAN	1.96	6.23	3948.44
ENGINEMAN	3.29	10.53	6642.66
ENGINEMAN	4.78	11.59	9634.79
DAMAGE CONTROLMAN	1.84	5.08	3709.08
GAS TURB SYS TECH ELEC	2.60	5.50	5238.13
STOREKEEPER	2.98	7.84	6005.87
CULINARY SPECIALIST	1.98	5.03	3987.10
CULINARY SPECIALIST	2.01	5.03	4045.92
CULINARY SPECIALIST	2.00	5.03	4038.49

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APPENDIX N. LCS FRTP 21-DAY WEEKLY WORK HOURS BY BILLET

Crewmember / Billet		PRODUCTIVE WORK			
		Avg Work Hours Each Week	Deviation from 70 Hr Work Week	Deviation from 67 Hr Work Week	Deviation from 63 Hr Work Week
1	CO AFLOAT CDR	69	-1	2	7
2	XO AFLOAT	69	-1	2	7
3	HOSPITAL CORPSMAN	103	33	36	40
4	CHIEF	98	28	31	35
5	OPERATIONS OFFICER	76	6	9	13
6	ASSIST OPERATIONS OFFICER	89	19	22	26
7	QUARTERMASTER	79	9	12	16
8	OPERATIONS SPECIALIST	91	21	24	28
9	OPERATIONS SPECIALIST	104	34	37	41
10	OPERATIONS SPECIALIST	84	14	17	21
11	BOATSWAINS MATE	89	19	22	26
12	MINEMAN	88	18	21	25
13	MINEMAN	95	25	28	32
14	INFORMATION SYSTEMS TECHNICIAN	90	20	23	27
15	INFORMATION SYSTEMS TECHNICIAN	79	9	12	16
16	COMBAT SYSTEMS OFFICER	70	0	3	7
17	ELECTRONICS MATERIAL OFFICER	81	11	14	18
18	ELECTRONICS TECHNICIAN	83	13	16	20
19	ELECTRONICS TECHNICIAN	91	21	24	28
20	ELECTRONICS TECHNICIAN	88	18	21	25
21	ELECTRONICS TECHNICIAN	78	8	11	15
22	FIRE CONTROLMAN	87	17	20	24
23	FIRE CONTROLMAN	81	11	14	18
24	FIRE CONTROLMAN	83	13	16	20
25	GUNNER'S MATE	91	21	24	28
26	GUNNER'S MATE	87	17	20	24
27	CHIEF ENGINEER	75	5	8	12
28	MAIN PROPULSION ASSIST	80	10	13	17
29	GAS TURB SYS TECH MECH	88	18	21	25
30	ELECTRICIAN'S MATE	82	12	15	19
31	ENGINEMAN	79	9	12	16
32	ENGINEMAN	93	23	26	30
33	ENGINEMAN	87	17	20	24
34	ENGINEMAN	95	25	28	32
35	CONTROLMAN	79	9	12	16
36	GAS TURB SYS TECH ELEC	89	19	22	26
37	STOREKEEPER	87	17	20	24
38	CULINARY SPECIALIST	80	10	13	17
39	CULINARY SPECIALIST	78	8	11	15
40	CULINARY SPECIALIST	79	9	12	16

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APPENDIX O. MA&D NONDISCLOSURE AGREEMENT



NON-DISCLOSURE AGREEMENT (Reciprocal)

THIS AGREEMENT made effective this 31st day of January, 2007, by and between Alion Science and Technology Corporation (hereinafter referred to as "Alion"), having offices at 11301 Corporate Blvd, Orlando, FL 32817 and _____ (hereinafter referred to as "_____"), having offices (or their principal place of business) at _____, (hereinafter referred to collectively as the "Parties").

WITNESSETH:

WHEREAS, the Parties possess certain confidential or proprietary technical and/or business information, know-how and trade secrets relating to their businesses and business operations. This includes, but is not limited to, information related to pricing, cash flow, business practices, scientific, technical and intellectual property of a Party or information it has a legal duty to protect which it considers proprietary and confidential, (hereinafter referred to as "Proprietary Information"). This confidential or proprietary information may be in any form to include oral, written or electronic; and

WHEREAS, the Parties desire to engage in discussions relating to Micro Saint/TCM (hereinafter referred to as the "Subject"), for purposes that may include, but not be limited to performing certain services, furthering scientific and/or technical understanding, or the exploration of business opportunities, (hereinafter referred to as the "Purpose"); however, in no event shall this Agreement be construed as creating a joint venture, partnership or other formal business relationship between the Parties; and

WHEREAS, each Party desires to disclose certain Proprietary Information ("Disclosing Party") to the other Party ("Receiving Party"), in furtherance of the Purpose and the Parties wish to define their rights and obligations with respect to any Proprietary Information provided by the Disclosing Party pursuant to this Agreement, and to protect such Proprietary Information in accordance with the terms of this Agreement;

NOW, THEREFORE, in consideration of being granted access to Proprietary Information, the Parties agree as follows:

I. PROPRIETARY INFORMATION

"Proprietary Information" as used herein shall mean documentary, recorded, machine readable, or other information in a tangible form originated by or peculiarly within the knowledge of the Disclosing Party that is not generally available to others. Proprietary Information includes, but is not limited to concepts, ideas, plans, financial data, cost data, pricing data, marketing data, drawings, photographs, standards, manuals, reports, formulae, processes, information, lists, trade secrets, computer programs, computer software computer databases, documentation, sketches, technical

data, and specifications provided such information is labeled "Proprietary Information" or other equivalent legend.

However, information will not be considered to be Proprietary Information: (a) If disclosed orally, visually, or in some other intangible form, at the time of disclosure it must be specifically identified to the Receiving Party as being Proprietary Information and must subsequently be reduced to a written summary within fifteen (15) days of its initial disclosure in order to receive the protection provided by this Agreement; or (b) If such Proprietary Information was known to the Receiving Party, or otherwise in the public domain, or publicly available prior to its disclosure under this Agreement, or became lawfully known to the Receiving Party from a source other than the Disclosing Party without breach of this Agreement by the Receiving Party; or (c) or is approved for release by the prior written approval of the disclosing Party; or (d) if such Proprietary Information was disclosed by the disclosing Party to a third party without a similar restriction on the rights of such third party; or (e) is developed independently by or for the receiving Party without use of the Proprietary Information.

For the purpose of the preceding, disclosures made to the Receiving Party under this Agreement which are specific in nature, and for which the information disclosed exceeds or enhances that which is otherwise available or previously disclosed shall not be deemed to be within the foregoing exceptions merely because they are embraced by general disclosures in the public domain or in the possession of the Receiving Party or any third party. In addition, any combination of features shall not be deemed to be within the foregoing exceptions merely because individual features are in the public domain or in the prior possession of the Receiving Party or any third party, but only if the combination itself and its principle of operation are in the public domain or in the possession of the Receiving Party or any third party.

2. DUTY TO PROTECT

With regard to Proprietary Information disclosed pursuant to this Agreement, the Receiving Party agrees as follows: (a) To maintain in confidence the Proprietary Information and shall exercise equivalent security measures and degree of care as those which the Receiving Party applies to its own proprietary or confidential information; (b) To make use of the Proprietary Information only for the purposes specified in this Agreement; (c) Not to disclose such Proprietary Information to third parties without: (i) obtaining prior written consent of the Disclosing Party; (ii) ensuring that such third party has executed a nondisclosure agreement with the Disclosing Party or, in the alternative, having such third party execute a nondisclosure agreement with the Receiving Party which contains terms and conditions consistent with the requirements as set forth herein as well as a provision making the Disclosing Party a third party beneficiary to such agreement, and in either case, (iii) providing a copy of such third party non-disclosure agreement to the Disclosing Party; (d) To only disclose such Proprietary Information to its employees who have been determined to have a need to know, have been advised of the proprietary nature of the Proprietary Information being disclosed, advised of their obligations

as set forth in this Agreement to keep such Proprietary Information confidential, and who are under an obligation to the Receiving Party to preserve Proprietary Information in confidence; and (e) Not to use such Proprietary Information to benefit itself or to damage the Disclosing Party; and (f) Not to mechanically or electronically copy or reproduce such Proprietary Information without the prior written consent of the Disclosing Party.

3. EXCLUDED INFORMATION

However, the Receiving Party will not be liable for:

- (a) Disclosure of Proprietary Information pursuant to, or required by, applicable law, regulation, or legal or administrative process. In such event, the Receiving Party agrees to promptly notify the Disclosing Party in writing of such demand or obligation to enable the Disclosing Party to seek, at its sole discretion, the appropriate remedy, or relief. Further, the Receiving Party agrees to furnish only that portion of the Proprietary Information which the Receiving Party is advised by counsel, in writing with a copy to the Disclosing Party, is legally required to be disclosed. In no event shall any provision in this Agreement be interpreted to require either Party to violate any lawful order; or
- (b) Unauthorized or inadvertent disclosure of Proprietary Information by employees of the Receiving Party provided the Receiving Party (i) protects such Proprietary Information to the extent normally used in safeguarding its own Proprietary Information, but in no event less than a reasonable degree of care, (ii) notifies the Disclosing Party in writing immediately upon the occurrence of any unauthorized release of Proprietary Information, whether inadvertent or otherwise, (iii) uses every effort at its means to retrieve such Information, and to prevent any further dissemination of such Information; or
- (c) Use or disclosure of Proprietary Information after such Proprietary Information is no longer proprietary in accordance with the terms of this Agreement, whichever is earlier.

4. EXPORT COMPLIANCE REGULATIONS

Products, services, and/or technical data provided or disclosed in performance of this Agreement may be subject to required and continuing U.S. Government approvals, clearances, regulations, and export/import and re-export requirements, including the U. S. Department of State International Traffic In Arms Regulations (Title 22, CFR Parts 120-130), the U.S. Department of Commerce Export Administration Regulations (Title 15, CFR 730-774), and any other U.S. Government regulation applicable to the export/import, re-export, or disclosure of such controlled technical data (or the products thereof) to Foreign Nationals. Parties acknowledge and agree to comply with all such U.S. regulations regarding export/import, re-export, or disclosure and will obtain any and all such registrations, licenses, agreements, approvals and/or certifications, as may be required by regulations for the export of the products, services, and/or technical data being provided under this Agreement before initiating performance.

5. LIMITATIONS AND WARRANTY

The Receiving party shall make no commercial use of the Proprietary Information and agrees that this Agreement shall not be construed as granting any right or license under any copyrights, inventions, or patents now or hereafter owned or controlled by the Disclosing party. Nothing in this Agreement shall preclude, impair, or restrict either party from continuing to engage in its business except in breach of the terms of this Agreement.

Although the Parties will endeavor to make sure that the Proprietary Information is reliable, the Parties understand and agree that the neither Party makes any representation or warranty as to the accuracy or completeness of the disclosed Proprietary Information. The Receiving Party agrees that neither the Disclosing Party nor its agents or shareholders shall have any liability hereunder to the Receiving Party or any of its representatives resulting from the use of the Proprietary Information by the Receiving Party or such representatives. Furthermore, any such disclosure shall not constitute any representation, warranty, assurance, guaranty or inducement concerning the infringement of any patent or other rights of others. **NO WARRANTY OF ACCURACY, SUITABILITY, USEFULNESS, OR COMPLETENESS OF ANY PROPRIETARY INFORMATION IS PROVIDED HEREIN.**

6. TERM, TERMINATION, AND CONTINUING OBLIGATION

This Agreement shall commence upon the Effective Date and continue for a period of one (1) year unless earlier terminated by either Party upon thirty (30) days written notice to the other Party. The Receiving Party shall retain in confidence the Proprietary Information for the period of three (3) years after termination or expiry of this Agreement. Notwithstanding the forgoing, the provisions concerning nondisclosure of Proprietary Information received under this Agreement shall survive the expiration or termination of this Agreement. Upon the request of the disclosing Party or upon the completion of the term of this Agreement, whichever is sooner, the receiving Party shall (i) cease use of Proprietary Information received from the disclosing Party, (ii) destroy all such Proprietary Information, including all copies thereof, and (iii) furnish the disclosing Party with written certification of destruction. Alternatively, upon request of the disclosing Party, the receiving Party shall return all such Proprietary Information, including any and all copies that the receiving Party has made, to the disclosing Party.



7. MISCELLANEOUS

(a) This document contains the entire agreement between the Parties, and supersedes any prior oral or written agreements, understandings, or communications with respect to the subject matter of this Agreement. No agreements or understandings that vary, extend or otherwise modify this Agreement will be binding upon either Party unless in writing and signed by a duly authorized representative thereof.

(b) All provisions of this Agreement are intended to be interpreted and construed in a manner to make such provisions valid, legal, and enforceable. The invalidity or unenforceability of any phrase or provision shall in no way affect that validity or enforceability of any other portion of this Agreement, which shall be deemed modified, restricted, or omitted to the extent necessary to make the Agreement enforceable.

(c) It is further agreed that no failure or delay in exercising any right, power or privilege hereunder will operate as a waiver thereof, nor shall any single or partial exercise thereof preclude any other or further exercise of any right, power or privilege hereunder.

8. NOTICE

The individuals identified below are designated as the point of contact for receiving Proprietary Information disclosed pursuant to this Agreement. All notices, certificates, acknowledgements and other reports required or permitted hereunder shall be in writing and shall be deemed properly delivered when duly mailed by registered letter to the other Party at its address as follows, or to such other address as either Party may, by written notice, designate to the other. The Parties to this Agreement may change their designated point of contact in either case upon written notice to the other Party.

IN WITNESS WHEREOF,
and year first above written.

(Insert Company Name)

By:

Name:

Title:

Address:

Phone:

Date:

9. REMEDIES

The Parties acknowledge that monetary damages may not be a sufficient remedy for unauthorized disclosure of Proprietary Information and that Disclosing Party shall be entitled, without waiving any other rights or remedies, to such injunctive or equitable relief as may be deemed proper by a court of competent jurisdiction.

10. DISPUTES

Each Party agrees to notify the other Party in a timely manner of any claim, dispute, or cause of action arising under or related to this Agreement and to negotiate in good faith to resolve any such issues. This Agreement and the obligations of the Parties hereunder shall be governed, interpreted, construed, and enforced in accordance with the laws of the Commonwealth of Virginia, without reference to its principles of conflict of laws. The Parties hereby consent and agree to the personal jurisdiction and venue of any state or federal court of competent jurisdiction located within the Commonwealth of Virginia with respect to any such claim, dispute, or cause of action and waive any defense or objection to the exercise of personal jurisdiction and/or venue by any such court.

11. ASSIGNMENT

This Agreement shall be binding upon and inure to the benefit of the Parties and their respective successors and assigns. Neither Party may assign or transfer its rights or obligations under this Agreement without the prior written consent of the other; provided, however, that either Party may, without consent, assign this Agreement as a result of a merger or a sale of all or substantially all of the assets or stock of that Party or to a parent, subsidiary or affiliate as part of any internal reorganization.

Alion Science and Technology Corporation

By:

Name:

Title:

Address:

Phone:

Date:

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